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The application of Konokol to guitar improvisation and composition

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The Application of Konokol to Guitar Improvisation and Composition

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USE OF THESIS

Abstract

This dissertation is an exploration of the rhythmic concepts used in two South Indian musical theory concepts, *solkattu* and *konokol*. *Konokol* application largely depends on instrument limitations and musical contexts. The principle focus here is on my personal application of *konokol* to the guitar both through composed and improvised music. A detailed study of *konokol* was undertaken through private lessons in India and personal experimentation to determine how these concepts could be adapted to Western improvisation, harmony and composition, as well as right-hand classical guitar and plectrum techniques. This was done intuitively by exploring guitar techniques and *konokol* simultaneously. The outcome of this study was a process applied to guitar composition and improvisation. Graphic numerical tables and geometrical representations are outlined in this dissertation as a guide to understanding this process.

The second outcome of this research includes a series of Western compositions improvised and through-composed. This outcome explores a fundamental concept, the practical applications of *konokol* and *mrdangam* patterns to guitar composition and guitar improvisation. The appendices include a practical reference guide to many of these concepts, providing a valuable and a beneficial resource for any musician who would like to use and understand rhythmic concepts outside the Western musical tradition. A compact disc of my original compositions demonstrating my application of *konokol* concepts and theories to guitar composition is also included as part of this research. This dissertation presents an alternative framework and methodology to the Western canon of rhythmic knowledge and involves rethinking numbers, rhythm and phrasing in a manner that is essentially different to the Western pedagogy of rhythmic knowledge. Possible future research on the collective memory and fractal design of *konokol* and how this is related to memory is also proposed.

Keywords: Classical guitar, jazz guitar, composition, *konokol*, *solkattu*, rhythm, improvisation, Indian music, Western music, Hindustani music, Carnatic music, *mora*, *mukthayam tihai, korvai.*

Declaration of Original Work

I, Glenn Rogers hereby certify that to the best of my knowledge and belief, this thesis does not incorporate any material submitted for a previous degree or diploma or contain any material written by another person except where referenced.

Signed,

Glenn Andrew Rogers

30th December 2017

Acknowledgments

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I am deeply grateful to my teachers Erode Nagaraj, Samuel J. Dass and Vidwan Bangalore Sri Amrit. N. These teachers showed great generosity in sharing their knowledge of music and Indian culture with me. I learnt *konokol* from Sri Amrit and Sri Nagaraj in Bangalore and Chennai.

My *konokol* journey began with John McLaughlin's Shakti albums, where I heard *konokol* for the first time. I was both mystified and intrigued: my journey had started. I studied raga in North India in 1985 with various teachers, not knowing the difference between North and South Indian music. I later returned to South India in 2010 specifically to study *konokol* with Sri Amrit and Sri Nagaraj for four months. Sri Amrit is the son of virtuoso violinist Vidwan Sri Basavanagudi G. Nataraj. At the age of five, he started learning *mrdangam* from Vidwan Sri M. Vasudeva Rao and continued training under Vidwan Sri A. V. Anand. He had the fortune of learning *kanjira* from the legendary Vidwan Sri G. Harishankar. Sri Amrit is the worthy successor to the throne of his guru Sri G. Harishankar. He upholds this tradition of *kanjira,* playing and taking forward his guru's legacy.

Sri Erode Nagaraj learnt the art of *mrdangam* initially from Palladam Sri V. Ramachandran and has been the disciple of Sangeetha Kalanidhi Padmabushan Umayalpuram Sri K. Sivaraman for the past 21 years. He is a full-time professional *mrdangam* player and has been a lecturer at the 'Thanjavur Vaidyanatha Iyer School for Percussion' in Chennai, since 1998.

This thesis has been edited by Elite Editing, and editorial intervention was restricted to Standards D and E of the *Austraialn Standards for editing practice.*

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Indian technical terms have been italicised throughout and spelled according to their common usage in current academic literature. However, some terms and spellings have been transliterated from Hindi, Tamal and Kannada spellings commonly used in Indian music. Most of these alternative spellings were taught to me by different teachers (alternatives, in general, have not been noted).

Glossary

Aksara: Refers to the beat in a tala cycle and is indicated by one of the hand gestures. It also means 'syllable' in certain contexts.

Anudrutam: Indicated by a clap (symbol = U).

Antara: The second part of a composition emphasising the higher octave.

Asthai: The first and fixed part of a composition in the main octave of a raga.

Asvari: The same as the Aeolian mode but sometimes played with a flat *re*.

Avarta: One cycle of a *tala*.

Carnatic music: Music associated with South India.

Chakradhar tihai: A *tihai* that is repeated (3 x 3) with the last note of the last phrase ending on the *sam* (Hindustani classical).

Chikari: The drone strings of an Indian instrument used for rhythmic articulation.

Drutam: A clap and a wave (symbol = 0).

e, a, m, i, p: The guitarist's right-hand fingers starting from the little finger.

Eka tala: A *tala* made up of a single clap and finger counts.

Farehns: The free rolling or flowing use of *konokol* syllables (*urutu*), meaning 'rolling' in Tamil.

Gamaka: Involves the variation of pitch of a note, using heavy, forceful oscillations between adjacent and distant notes. Each raga has specific rules on the types of *gamaka* that might be applied to specific notes, and the types that may not.

Gopucca yati: A *yati* where each successive phrase becomes shorter.

Janya: A raga derived from another raga.

Jati: The internal pulse divisions of the *aksara*.

Jhala: Involves the constant repetition of pitches including the drone notes and is used in the climax of Indian classical compositions.

Jor: Unmetered section of an instrumental performance where rhythm is introduced.

Hamsadhvani: A raga built on the first, second, third, fifth and seventh of a major scale (Carnatic).

Kanjira: A small frame drum made from jackwood and lizard skin.

Karvai: A pause or rest.

Khali: A beat of *tala,* which is signified as empty, counted with a wave of the hand and recognised by closed tabla *bols*.

Konokol: The art of vocalising *mrdangam* patterns for performance.

Korvai: A Tamil word meaning 'patterns' or 'aesthetically made artistic patterns'. The *korvai* at base is pure mathematics and is used primarily by percussionists to form accompaniments and solos.

Laghu: A clap followed by finger counts in a *tala* cycle.

Matra: A single count or beat used in Hindustani music.

Melakarta: The collection of fundamental ragas in Carnatic music. There are 72 ragas in total, although composers do create new ones.

Mora: A rhythmic ending cadence usually of three identical phrases.

Mrdangam: A South Indian two-headed drum.

Mukthayam: A rhythmic cadence usually repeated three times.

Naad: The cosmic sound or vibrations of the cosmos.

Nadai: The number of subdivisions per *aksara*.

Poorvanga: First half of a korvai allowing gaps on the last repeat.

Sam: The first beat of a *tala* cycle (symbol = X).

Sama yati: A *yati* in which equal-length phrases occur.

Samam: The first beat of the *tala* cycle (symbol = X).

Solkattu: The vocalisation of *mrdangam* syllables used for teaching.

Srotovaha: A *yati* pattern where each successive phrase becomes longer.

Srutis: Microtones, also related to intonation.

Swara: The seven notes in Indian music are called '*swaras*' and named *shadja*, *rishabh, gandahr, madhyam, pancham, dhaivat* and *nishad*. They are shortened as sa, re, ga, ma, pa, dha and ni, and are written as s, r, g, m, p, d and n. The equivalent is the Western Solfège system doh, re, me, fa, la, ti, doh.

Tala: A rhythmic cycle of a finite number of beats shown through hand gestures.

Tani avartanum: A collective percussion composition.

Tanpura: A lute-type instrument played by plucking the open stings and used as an accompaniment instrument.

Tihai: A Hindustani cadential formula repeated three times, where the last note of the last phrase ends on the *sam*.

Utharaanga: The second half of a *korvai* with no gaps on the last repeat.

Vadi: The dominant note of a given raga.

Vibhag: Represents the duration of rhythmic phrasing in Indian classical music, made up of divisions of beats within the time cycle. Vibhag is a rough equivalent of bars in Western music.

Vilambit khyal: A very slow melismatic and rhythmically free style of singing.

Yaman: Equivalent to the Western Lydian scale, (North Indian raga).

Yati: Rhythmic pattern or groupings (Carnatic).

Chapter 1: Introduction

1.1 What are Konokol and Solkattu?

Konokol is the oral tradition of spoken rhythmic patterns used in the performance of South Indian music. *Konokol* can be performed solo, in a group or in conjunction with other instruments. These rhythmic 'syllables' originally came from the sounds of the Indian drum called the *mrdangam*. All *konokol* syllables are rhythmically flexible and can represent any rhythm duration. It would be rare to find a Carnatic musician not familiar with *konokol,* and although *konokol* is an integral part of Carnatic music, it is not always heard in Carnatic performances in India today.

The syllables of *konokol* differ slightly from *solkattu*[1] syllables as they are often modified to facilitate speed and vocal dexterity. *Solkattu* means 'words bound together' and is the theoretical foundation of rhythm in South Indian music. The *solkattu* vocal sounds deliberately emulate the sounds of the *mrdangam* and are primarily used as a tool for teaching and learning complex rhythms and applying them to the *mrdangam, kanjira* or *ghatam*. *Solkattu* is comparable to the Western 'sol-fa' system—in other words, you must say it before you play it. This idea has parallels with the recitation of pitch in Western music; however, the focus of *solkattu* is on rhythm not pitch. The theoretical concepts of both *solkattu* and *konokol* can extend to what is practically impossible to play because it is based on linear mathematical sequences, which are infinite. Any mathematical linear sequence can be applied to the practice of *konokol,* and although there are many standard phrases to be learned, the practice is limited only by the performer's imagination.

Konokol is used extensively in other art forms, such as Indian dance and drama. *Solkattu,* however, is generally used when teaching the *mrdangam. Solkattu* syllables changed over time and became an entity in their own right: this development was due to new performance practices. For example, some *solkattu* syllables were very hard to perform accurately at fast speeds. The syllables in *solkattu* changed to accommodate this performance practice and developed into

[1]*Solkattu* vocal sounds deliberately emulate the sounds of the *mrdungam* and are used when teaching percussion instruments (Nelson, 2008, p. 5).

what is now known as *konokol*. The art of *konokol* then became known as the recitation of rhythmic syllables in live performance (Sankaran, 2010, p. 1).

The syllables Indian musicians use are called *aksaras*. This term can be translated as 'pulse' or 'unit' and is the basic starting point in learning about South Indian rhythm. These syllables and patterns are strung together in aesthetic and calculated ways, enabling very long and complex mathematical structures to be vocalised, memorised and performed. *Konokol* can then be expressed on one's chosen instrument. The methodology of spoken syllabic structures and Indian music has always existed in a symbiotic relationship with percussion playing and has been the foundation in the dissemination of rhythmic knowledge. It is analogous to reading notated music for the Western classical musician. To the South Indian percussionist, *solkattu* is the symbol of his or her art when performed but extends further into a poetic art in itself.

1.2 Why Study Konokol?

It could be argued that the learning of rhythm in Western music is one of its most underdeveloped aspects compared with the rhythmic systems of other cultures. For example, the *Cambridge History of Western Music Theory* (Christensen, 2002). Lacks any discussion on complex rhythms. Historically, the Western rhythmic system seems simple compared with the South Indian rhythmic system. However, Western rhythmic structures and concepts are perfectly appropriate to the harmony to which they are counterpart. The relationship between harmony and rhythm in Western music is often inseparable and is an integral part of style. Because of this interrelationship, it could be argued that harmony in Western music is also a guiding principle in cyclic form. This is especially true for melodic and harmonic instrumentalists, and perhaps less so for drummers and percussionists. Arguably, it is both rhythm and harmony that are guiding principles in cyclic form in varying degrees for Western improvisers. The difference between the Western and Indian rhythmic systems is that there is no *advanced* rhythmic system to learn outside the Western repertoire. Consequently, this points to a lack of pedagogical rhythmic focus. For example, when improvising on static modal tunes, many improvisers lose the form, time or metre in static modal tunes because there is little harmonic movement and a lack of any significant rhythmic training to guide the performer. The pivotal reference point for many Western melodic improvisers is a change of harmony, and this is not always enough. Rhythm, harmony and melody are important guiding principles in relation to form. However, all these concepts are proportional references that guide a performer through a musical composition and are contingent on musical learning and cultural practices. *Konokol,* however, can give any musician transferable fundamental rhythmic skills without having to learn a new instrument; it provides both physical confidence and portability (Nelson, 2008, p. 5).

1.3 Harmony and Linear Rhythm

In Indian music, there is no concept of harmony, only of rhythm and melody. This is not to say harmony does not exist in Indian music, in fact it does when there are several instrumentalists, but still there is no harmonic conceptual framework within Indian music. Cyclic form, numbers, melody and hand movements combined are the guiding principles and are key to staying within *tala*. In South Indian music performance practice, there is usually someone physically demonstrating *tala* through hand gestures, whose function is similar to a that of a conductor in Western music.

This absence of harmony allowed Carnatic musicians to develop a sophisticated learning process and rhythmic system. For example, a Carnatic percussionist has a huge arsenal of *solkattu* patterns, which also include rests. These are learned aurally before playing an instrument and are eventually used in instrumental improvisation and accompaniments. Perhaps the most significant reason to learn *konokol* is the presentation and aesthetic arrangement of linear rhythmic patterns. Because Carnatic percussionists do not have the constraints of harmony and the music is based on mathematics, this allows for complex rhythmic diversity. Also, the aesthetic design of these phrases (e.g., *moras* and *korvais*[2]) are constructed in such a way that long complex rhythmic phrases can be remembered and performed easily. It is these particular aspects that are lacking in the Western educational practice of learning rhythm.

[2] *Korvai* is a complex final cadential structure ending with a mora.

With improvisation and world music becoming a dominant form of musical expression in the West, *konokol* is very useful and has universal potential as a conceptual tool to transfer rhythmic knowledge between musical cultures. The musician can use this tool to extend musical form, share an idea and add rhythmic complexity to a classical composition or jazz improvisation. In this thesis, I explore past usages of *konokol* in both jazz and classical contexts. Moreover, I explore the application of *konokol* to new musical and harmonic compositional forms and examine *konokol* phrases that are applicable to the performance requirements of the improvising and classical guitarist. The question I ask and examine throughout this thesis is: How can South Indian rhythmic ideas be incorporated in a meaningful way into my Western music, and does harmony restrict the use of complex linear rhythmic concepts in Western music? Moreover, the analysis of my compositions in this thesis is an exploration of the compositional problems and successes of marrying two disparate musics.

It is worth noting that the notated compositions presented in this thesis are exemplars of the use of *konokol* rhythmic patterns in a Western music context. The same rhythmic concepts are also used in the improvised compositions.

Chapter 2 outlines some Carnatic rhythmic concepts and Chapter 3 are examples of these theories applied to *konokol* and guitar. The exercises in Chapter 3 are examples and a basic framework for a more extended study. Chapter 4 gives examples of how to use *mukthayams* in an Indian and Western context on the classical and plectrum guitar. Chapter 5 includes examples of *mukthayams* in different time signatures and subdivisions and can be used as a reference for improvisation and composition. Chapters 6, 7, 8, 9, 10 and 11 involve an analysis of my compositions and the problems I faced using both Carnatic rhythms and Western harmony in my compositions.

Chapter 2: Rhythmic Theory

2.1 Konokol Syllables and Pronunciation

The pronunciation and spelling of *konokol* syllables differ considerably because of the differences in dialects, languages, aesthetics and audience expectations. English speakers often change *konokol* syllables because of pronunciation difficulties at fast tempos. This is because of the comparatively slow pace of the English language, the unfamiliar dental retroflex and the extra consonants used in Indian languages (Sankaran, 2010, p. 2). However, the phonetic flexibility of *konokol* allows any musician to learn it. Some of the Indian spellings and pronunciations include: *ta di gi na tom*, *ta di ki ta tom* and *tha dhin ke na tom*. Various attempts have been made to codify a system of spelling and notation and, as yet, no standard system has been achieved: as an oral tradition, *konokol* and *solkattu* are perfectly fluid and complete (Sankaran, 2010, p. 2). The *konokol* syllables chosen here are spelled with the English speaker in mind; there are many more but this is an ample amount to begin with. The information provided in Chapter 2 is a combination of concepts taught to me by Vidwan Bangalore Amrit and Erode Nagaraj and was the result of four months of lessons. The dots after a syllable indicate a rest and are equal to one aksara.

Simple *Konokol* Syllables	**Number**		***Laghu***
Ta	1		
Ta ka	2		
Ta ki ta	3		*Tisra*
Ta ka di mi	2 + 2	4	*Chatusra*
Ta ka ta ki ta	2 + 3	5	*Khanda*
Ta ka ta ka di mi	2 + 4	6	
Ta ki ta ka di mi	3 + 4	7	*Misra*
Ta ka di mi ta ka jo nu	4 + 4	8	
Ta ka di mi ta ka ta ki ta	4 + 5	9	*Sankirna*
Ta ka ta ki ta di gi na tom	2 + 3 + 5	10	

Alternative *Konokol* Syllables. Including the Ta di gi na tom family with rests.	**Beats**
Ta jo nu Ta di mi	3
Ta ka jo nu Ta ri ki ta ki ta ta ka	4
Ta di gi na tom Ta . . tom. Ta ki ta tom .	5
Ta . di gi na tom (with rests) Ta ki ta ta ki ta Ta ri ta ka jo nu	6
Ta . di . gi na tom (with rests) Ta ka ta di gi na tom Ta di . . gi na tom	7
Ta di . gi . na . tom (with rests) Ta ka ta di gi na tom	8
Ta . di . gi . na . tom (with rests) Ta ka di ku ta di gi na tom (Ta ki ta) x 3	9
Ta ki ta tom . ta di gi na tom (with rests) Ta ki ta ta . di . gi na tom Ta ka di ku ta di gi na tom Ki ta ta ka ta di gi na tom .	10

2.2 Hand Gestures and Symbols

Each tala is structured by components called *angas* which have different lengths. The combinations of *laghu, anudrutam* and *drutam* are represented symbolically through hand gestures. *Anudrutam* and *drutam* are constant, *anudrutam* has one beat, *drutam* two beats and *laghu* is variable consisting of five varieties which are three, four, five, seven and nine beats.

Symbol	***Anga***	***Kriya***	**Beats**
X	*Sam*	Clap (I have used this symbol for *sam*).	1
I	*Laghu*	Clap then variable finger counts starting from the little finger to the thumb, then returning to the little finger. (*e, a, m, i, p, i, m, a, e*) for guitarists.	Variable
U	*Anudrutam*	Clap.	1
O	*Drutam*	A clap and wave.	2
__		A line below text indicates double time.	
==		A double line below text indicates quadruple time.	

2.3 Thalam Table (35 Talas)

A *tala* is a rhythmic cycle. If a *tala* contains more beats than can be counted on five fingers, the counting continues onto the thumb and then backwards towards the little finger again, as in *misra jhampe tala* or *sankirna eka tala.* For a more comprehensive and theoretical understanding of the complete 108-*tala* table, see Sambamoorthy (1962, p. 151). Listed below are some of the main *talas* in practical use today.

	Talas						
	Dhruva	*Matya*	*Rupaka*	*Triputa*	*Jhampe*	*Ata*	*Eka*
Laghu	**1 0 1 1**	**1 0 1**	**0 1**	**1 0 0**	**1 U 0**	**1 1 0 0**	**1**
Tisra	**$1^3 0 1^3 1^3$**	**$1^3\ 0\ 1^3$**	**$0\ 1^3$**	**1^3 0 0**	**1^3 U 0**	**$1^3\ 1^3$ 0 0**	**1^3**
Beats	11	8	5	7	6	10	3
Chatusra	**$1^4 0 1^4 1^4$**	**$1^4\ 0\ 1^4$**	**$0\ 1^4$**	**1^4 0 0**	**1^4 U 0**	**$1^4\ 1^4$0 0**	**1^4**
Beats	14	10	6	8	7	12	4
Khanda	**$1^5 0 1^5 1^5$**	**$1^5 0\ 1^5$**	**$0\ 1^5$**	**1^5 0 0**	**1^5 U 0**	**$1^5\ 1^5$0 0**	**1^5**
Beats	17	12	7	9	8	14	5
Misra	**$1^7 0 1^7 1^7$**	**$1^7 0\ 1^7$**	**$0\ 1^7$**	**1^7 0 0**	**1^7 U 0**	**$1^7\ 1^7$0 0**	**1^7**
Beats		16	9	11	10	18	7
Sankirna	**$1^9 0 1^9 1^9$**	**$1^9 0\ 1^9$**	**$0\ 1^9$**	**1^9 0 0**	**1^9 U 0**	**$1^9\ 1^9$0 0**	**1^9**
Beats	29	20	11	13	12	22	9

In Carnatic drumming, the numbers 4, 3, 7, 5 and 9 have a hierarchical and primary importance and represent the five *jatis* and *laghu.* This order developed historically from the Hindu–Arabic system and favoured particular numbers through various ways of counting. They are listed here in order of importance and they permeate all aspects of Carnatic drumming, including extended improvisations *mora* and *korvai,* as well as *tala*. The numbers 4 and 3 were the first to be recognised by theorists as a legitimate way of constructing a *tala* (Viswanathan & Allan, 2004, pp. 34–36). Europe also adopted the Hindu–Arabic system and, similarly, Western music has favoured time signatures and rhythms of 4 and 3 and their multiples (Benjamin, 2007, p. 10).

2.4 Examples of Different Notation Systems and Yati Patterns

There is no clear notation system as can be seen by the examples here. *Laghu* is written on the top and bottom.

1_4 0 0 = 8 beats, 1^9 01^9 1^9 = 29 beats (0 = clap + wave = 2 beats).

X I I I I (X =*sam,* I= beat).
Ta… di… gi… na… tom… = Chatusra nadai khanda eka tala = *Tala* in 5 with 4 counts per beat. Begins with a clap and finger counts, beginning from the little right-hand finger with dots indicating rests.

X I I I I (X =*sam,* I= beat).
Ta, di, gi, na, tom, ta, di, gi, na, tom = Chatusra nadai khanda eka tala = *Tala* in 5 with 4 counts per beat. Begins with a clap and finger counts, beginning from the right-hand little finger, commas indicating rests.

X . X X . X (X =*sam,* (.)= silent pulse).
Ta di gi na tom ta di gi na tom ta di gi na tom ta di = Tisra nadai, khanda chapu tala = *Tala* in 5 with 3 counts per beat. Begins with a clap and finger counts, beginning from the right-hand little finger, dots indicate a silent pulse.

Sankaran (2010, p. 28) states that multiple *nadais* are admissible and would include multiples. For example, *tisra* would include 6, 12, $1^1/_2$, $^3/_4$.

2.4.1 Gopucca yati

In *gopucca yati*, each successive phrase becomes shorter. The phrase translates as 'cow's tail'. This *gopucca yati* was given to me by my teacher Vidwan Bangalore Amrit. It is in *adi tala* and will take 36 cycles in 1st speed, 18 cycles in second speed, 9 cycles in third speed and 4 ½ cycles in fourth speed.

Ta . ki ta ki ta ta ka ta ki ta ta ki ta ta ka
Di . ki ta ki ta ta ka ta ki ta ta ki ta ta ka
Tom . ki ta ki ta ta ka ta ki ta ta ki ta ta ka
Nam . ki ta ki ta ta ka ta ki ta ta ki ta ta ka 16 beats
Ta . ki ta ta ka ta ki ta ta ki ta ta ka
Di . ki ta ta ka ta ki ta ta ki ta ta ka
Tom . ki ta ta ka ta ki ta ta ki ta ta ka
Nam . ki ta ta ka ta ki ta ta ki ta ta ka 14 beats—ki ta
Ta . ki ta ta ki ta ta ki ta ta ka
Di . ki ta ta ki ta ta ki ta ta ka
Tom . ki ta ta ki ta ta ki ta ta ka
Nam . ki ta ta ki ta ta ki ta ta ka 12 beats—ta ka
Ta . ta ki ta ta ki ta ta ka
Di . ta ki ta ta ki ta ta ka
Tom . ta ki ta ta ki ta ta ka
Nam . ta ki ta ta ki ta ta ka 10 beats—ki ta
Ta . ki ta ki ta ta ka
Di . ki ta ki ta ta ka
Tom . ki ta ki ta ta ka
Nam . ki ta ki ta ta ka 8 beats like opening
Ta . ki ta ta ka
Di . ki ta ta ka
Tom . ki ta ta ka
Nam . ki ta ta ka 6 beats—ki ta
Ta . ki ta
Di . ki ta
Tom . ki ta
Nam . ki ta 4 beats—ta ka
Ta .
Di .
Tom .
Nam . ||2 beats

2.4.2 Sama yati

Each phrase in *sama yati* is symmetrical and has the same shape and length. This *mora*[3] will take one cycle of *adi tala* in third speed, two cycles in second speed, and four cycles in 1st speed. Here are two versions of the same *mora* written slightly differently (*tam₃* can also be written as *tam*… and indicates three rests).

Di gu ta ri ki ta ta ka tam 3 Di gu ta ri ki ta ta ka tam…
Di gu ta ri ki ta ta ka tam 3 Di gu ta ri ki ta ta ka tam…
Di gu ta ri ki ta ta ka ||tam Di gu ta ri ki ta ta ka ||tam
Sam Sam

2.4.3 Srotovaha yati

Srotovaha yati is the opposite of *gopucca yati*, in that each successive phrase becomes longer.

. Ta tam3 6 beats
ki ta ta ka tam3 8 beats
Ta ri ki ta ta ka tam 3 10 beats
Di gi ta ri ki ta ta ka ||Tam 8 beats = 32 beats

X	I	I	I	X	O	X	O
. Ta tam .	. . ki ta	Ta ka tam .	. . ta ri	ki ta ta ka	Tam . . .	Di gu ta ri	ki ta ta ka

2.4.4 Damaru yati

Damaru yati is a combination of *gopucca* and *srotovaha yati* and is named after the hourglass shaped *damaru* drum. The *damaru yati* takes two cycles of *adi tala* in third speed, it also works well when melodically arranged and retrograded.

Di gi ta ri ki ta ta ka tam 3 12 beats
Ta ri ki ta ta ka tam 3 10 beats
ki ta ta ka tam3 8 beats
ta ka Tam 3 beats
Ta tam3 5 beats
ki ta ta ka tam3 8 beats
Ta ri ki ta ta ka tam 3 10 beats
Di gi ta ri ki ta ta ka ||Tam 8 beats = 64

[3] *Mora*: A rhythmic ending cadence usually of three identical phrases.

2.4.5 Mrdanga yati

In mrdanga yati the mrdangam shape phrases increase then decrease in length. Named after the *mrdangam,* it is a combination of *srotovaha* and *gopucca yatis.* This *mrdanga yati* takes two cycles of *adi tala* to complete and is constructed of increasing and decreasing *ta di gi na tom* patterns.

Tom
ta Tom
ki ta Tom
Ta ki ta Tom
Ta ki ta na tom
Ta ki ta gi na tom
Ta ki ta di gi na tom
Ta ki ta ta di gi na tom
Ta ki ta di gi na tom
Ta ki ta gi na tom
Ta ki ta na tom
Ta ki ta Tom
ki ta Tom
ta Tom
Tom || Tam = 64 beats

2.4.6 Vishama yati

Vishama yati represents phrases of random lengths and of no definite shape or order. It can be combinations of all of the above.

2.4.7 Mora

Yati is a concept that deals with geometric shape and is applied to all aspects of Carnatic music. *Yati*, and more so *mora* patterns are fractal[4] by nature and exhibit a logical and constant repeating pattern that is displayed at every level, meaning that its overall logic and structure is both complex and simple. For example, a sub *mora*, also called a compound *mora*, demonstrates a fractal logic in that it is contained within a larger *mora*. For example, the *mora* below contains related *moras* of different lengths within it.

X I I I X O X O X
Ta ka di mi ta ka jo nu tom… Ta ka di mi ta ka jo nu tom…Ta ka di mi ta ka jo nu ||tom…
|--*Mora*--||*sam*
Ta ka di mi ta ka jo nu tom… Ta ka di mi Ta ka jo nu tom. Ta ka jo nu tom. Ta ka jo nu ||tom…
|-------------------*sub mora*--------------------------|
Ta ka di mi ta ka jo nu tom… Ta ka di mi Ta ka jo nu tom. jo nu tom. jo nu tom. jo nu ||tom…
|-------*sub sub mora*--------|

Many *yati* and *mora* patterns usually involve evolving expanding and contracting symmetry. Small *yati* patterns are easily adaptable to Western melodic improvisation and rhythmic cadences, especially when dealing with simple, static or modal harmony. Longer *yati* patterns and harmony can be problematic, a point discussed in Chapter 11 Variation 6. The following *yati* patterns and exercises in Chapter 3 are to be played at different speeds while keeping the same tempo, it is however of great value to apply the three speed formula to any Carnatic rhythm. A more detailed examination of *yati* patterns can be found in Haternberger's PhD (Hartenberger, 1974, p. 32).

[4] A term coined by Mandelbrot meaning 'broken' or 'fractured'. It is used to extend the concept of theoretical fractional dimensions to geometric patterns in nature.

Chapter 3: Konokol Patterns and Exercises

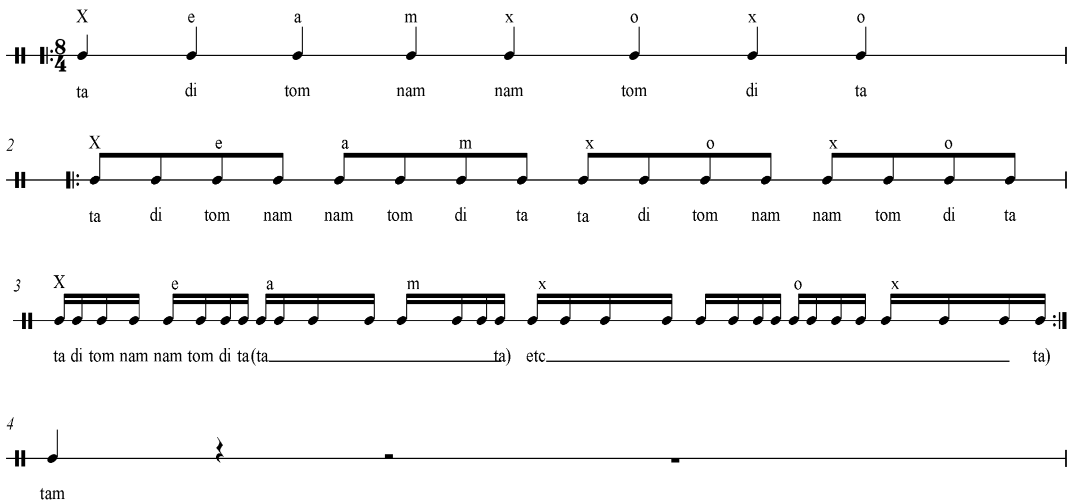
3.1 Background

The conventions of Western and Indian music are similar in that musical tension is often built up before returning to a recapitulation or a new section. In Carnatic music, mathematical calculations play a very important role in this, as do dominant–tonic relationships and pitch structures in Western tonal music.

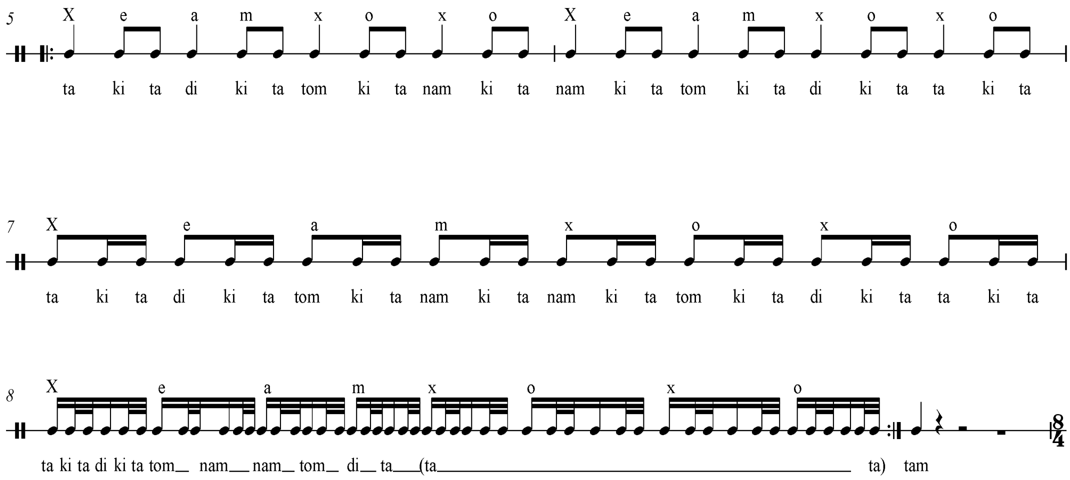
Historically in Western music, it has been harmonic complexity that creates tension rather than rhythmic complexity, although harmonic tension cannot always be divorced from its rhythm. For example, classical composers like Olivier Messiaen compose very complex combined rhythms and harmony (Messiaen, 1956, p. 3). Moreover, many large ensemble compositions are not improvised and often the linear rhythmic aspect is subservient to harmonic density. The difference in Carnatic music is that it has a rhythmic tradition that enables musicians to improvise very complex rhythms spontaneously and as an ensemble. This involves hearing and picking up rhythms as the composition develops, much like a small jazz ensemble improvising over complex harmony that has deviated from the original harmony. This is due to a very structured and long learning process that focuses on an enormous vocabulary of rhythmic concepts. The exercises presented in 3.1 to 3.8 involve expanding and contracting patterns in three speeds (1:2:4)—slow medium and fast. There is a geometric relationship between the three speeds. For example, a *konokol* pattern at fast speed is exactly twice as fast as the same pattern when recited at medium speed (Sankaran, 2010, p. 7). These exercises formed part of my early lessons given to me by Erode Nagaraj and Vidwan Bangalore Amrit to develop rhythmic fluency, vocal dexterity and the three-speed formula.

3.2 Ta Di Tom Nam Nam Tom Di Ta

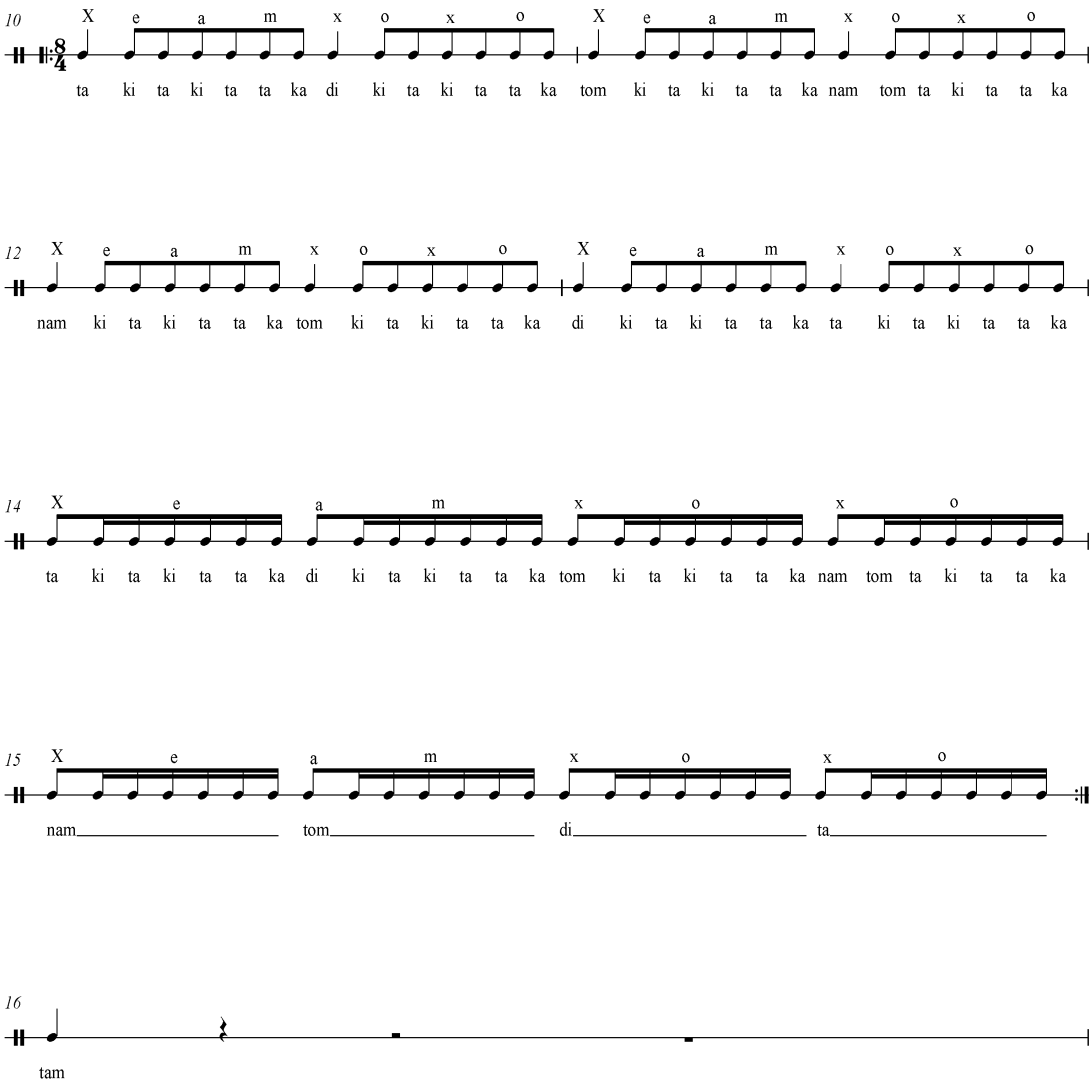
Exercise 1



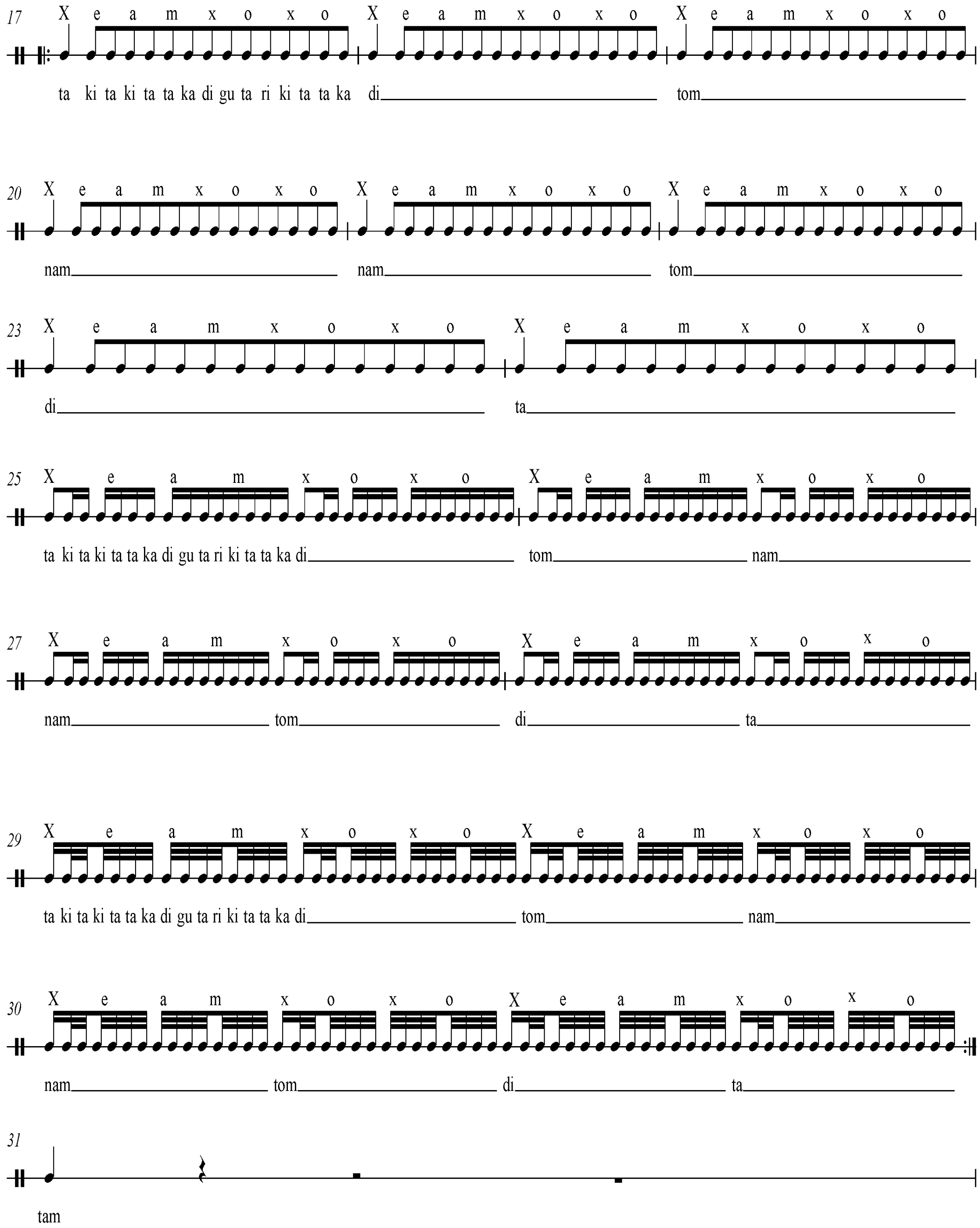
Exercise 2



Exercise 3


10
X e a m x o x o X e a m x o x o
ta ki ta ki ta ta ka di ki ta ki ta ta ka tom ki ta ki ta ta ka nam tom ta ki ta ta ka
12
X e a m x o x o X e a m x o x o
nam ki ta ki ta ta ka tom ki ta ki ta ta ka di ki ta ki ta ta ka ta ki ta ki ta ta ka
14
X e a m x o x o
ta ki ta ki ta ta ka di ki ta ki ta ta ka tom ki ta ki ta ta ka nam tom ta ki ta ta ka
15
X e a m x o x o
nam tom di ta
16
tam

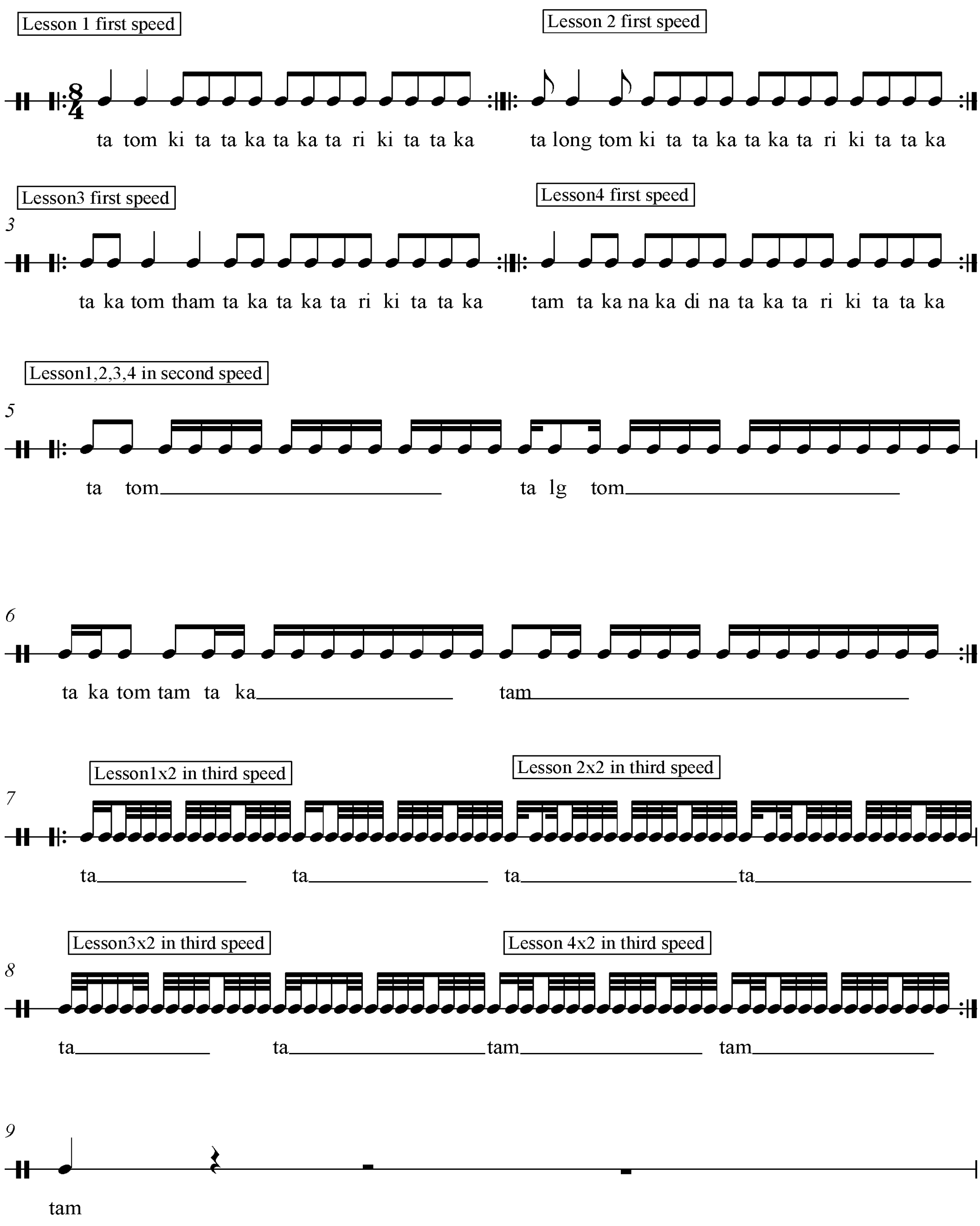
Exercise 4


17
X e a m x o x o X e a m x o x o X e a m x o x o
ta ki ta ki ta ta ka di gu ta ri ki ta ta ka di tom
20
X e a m x o x o X e a m x o x o X e a m x o x o
nam nam tom
23
X e a m x o x o X e a m x o x o
di ta
25
X e a m x o x o X e a m x o x o
ta ki ta ki ta ta ka di gu ta ri ki ta ta ka di tom nam
27
X e a m x o x o X e a m x o x o
nam tom di ta
29
X e a m x o x o X e a m x o x o
ta ki ta ki ta ta ka di gu ta ri ki ta ta ka di tom nam
30
X e a m x o x o X e a m x o x o
nam tom di ta
31
tam

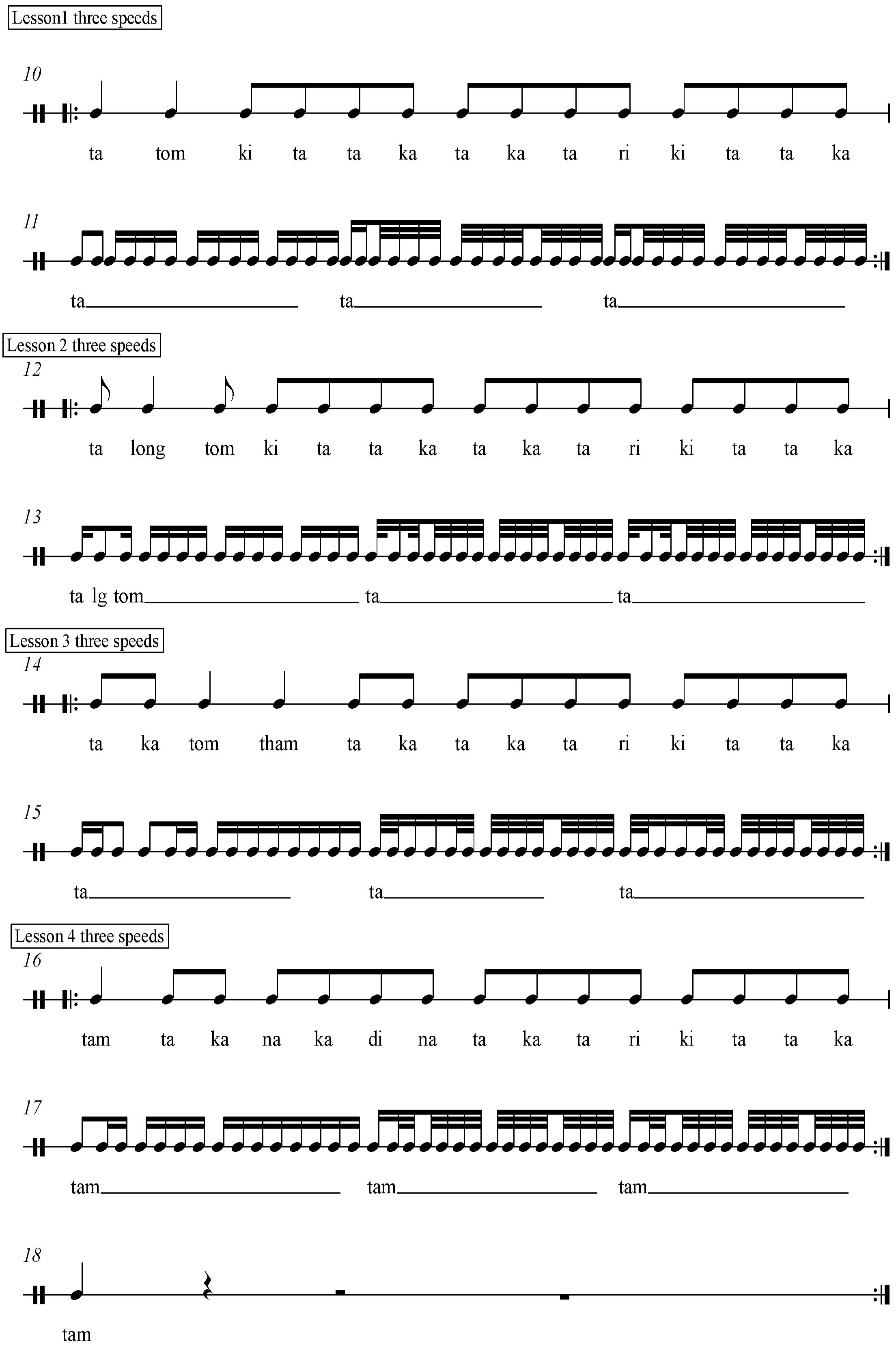
3.3 Pharans in Three Speeds

Pharans[5] translates as free flowing konokol syllables.

Pharans in Three Speeds



[5] *Pharans* is the free-flowing use of *konokol* syllables (*urutu*), meaning 'rolling' in Tamil. *Pharans* are usually performed in the last phase of the solo percussion section and they mark the beginning of the climax, usually before the *mora* or *korvai*. *Pharans* do not have any specific size (as in number of cycles) and can be expanded and contracted at the desire of the performer. Each *tala* has a general basic structure of *pharans,* which the performer can develop by adding similar patterns to the basic structure. These *pharans* exercises can be adapted to the guitar in full or in part thereof.

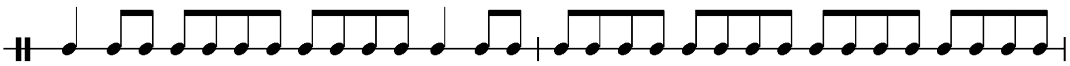


Lesson1 three speeds
10
ta tom ki ta ta ka ta ka ta ri ki ta ta ka
11
ta ta ta
Lesson 2 three speeds
12
ta long tom ki ta ta ka ta ka ta ri ki ta ta ka
13
ta lg tom ta ta
Lesson 3 three speeds
14
ta ka tom tham ta ka ta ka ta ri ki ta ta ka
15
ta ta ta
Lesson 4 three speeds
16
tam ta ka na ka di na ta ka ta ri ki ta ta ka
17
tam tam tam
18
tam

Lesson 5 in first speed

tam ta ka ta tom ki ta ta ka tam ta ka ta tom ki ta ta ka ta ka ta ri ki ta ta ka

Lesson 6 in first speed



tam ta ka ta ka ta ri ki ta ta ka tam ta ka ta ka ta ri ki ta ta ka ta ka ta ri ki ta ta ka

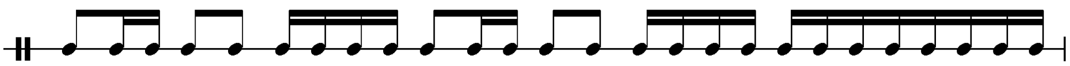
Lesson 7 in first speed

ta long gu tom ki ta ki ta ta ka ta long gu tom ki ta ki ta ta ka ta ka ta ri ki ta ta ka

Lesson 8 in first speed

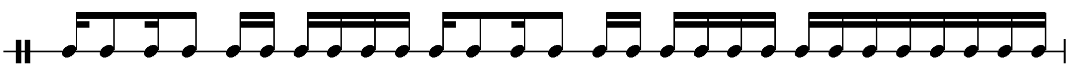
ta long gu tom ta long gu tom ta long gu tom ki ta ki ta ta ka ta ka ta ri ki ta ta ka

Lesson 5,6,7,8, in second speed

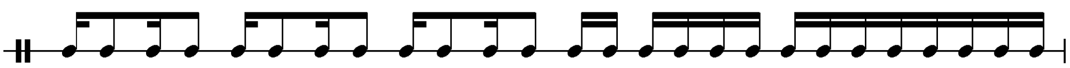


tam ta ka ta tom ki ta ta ka tam ta ka ta tom ki ta ta ka ta ka ta ri ki ta ta ka

tom ta ka ta ka ta ri ki ta ta ka tom ta ka ta ka ta ri ki ta ta ka ta ka ta ri ki ta ta ka

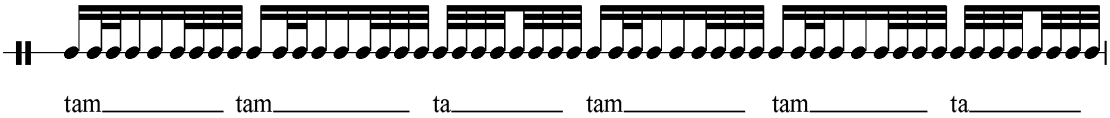


ta long gu tom ki ta ki ta ta ka ta long gu tom ki ta ki ta ta ka ta ka ta ri ki ta ta ka

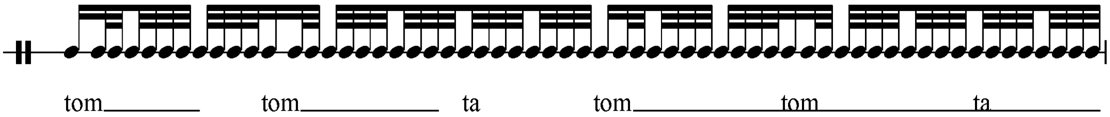


ta long gu tom ta long gu tom ta long gu tom ki ta ki ta ta ka ta ka ta ri ki ta ta ka

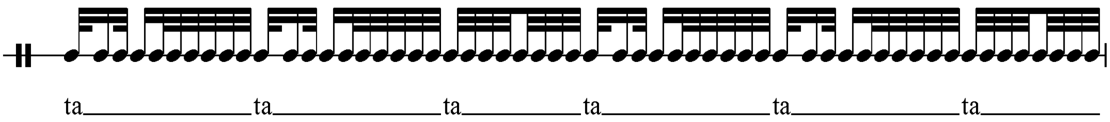
Lesson 5x2 in third speed



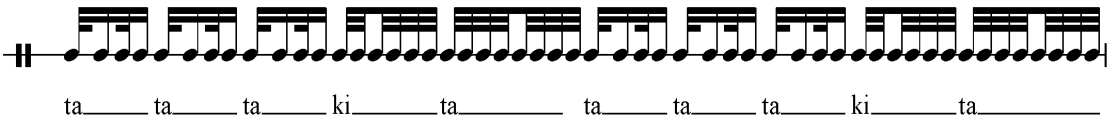
Lesson 6x2 in third speed



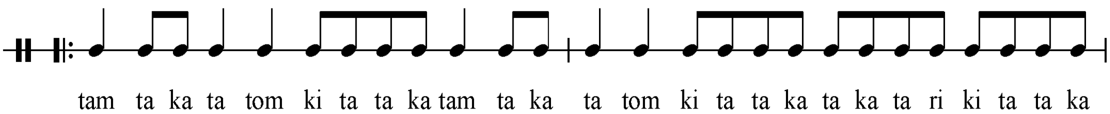
Lesson 7x2 third speed

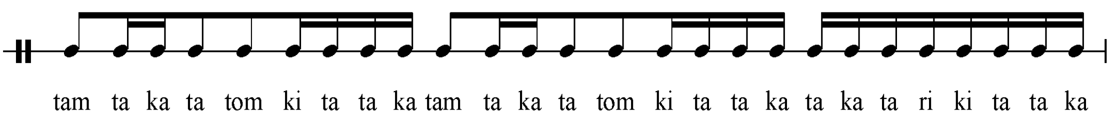


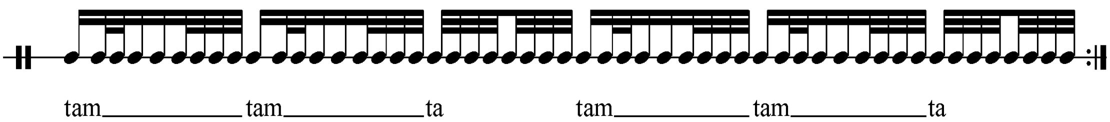
Lesson 8x2 third speed



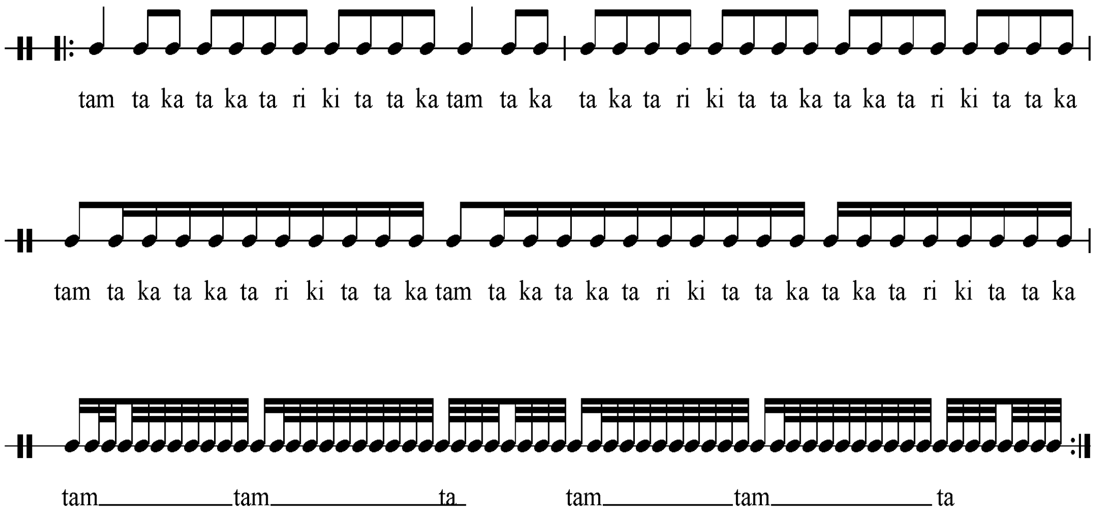
Lesson 5 three speeds





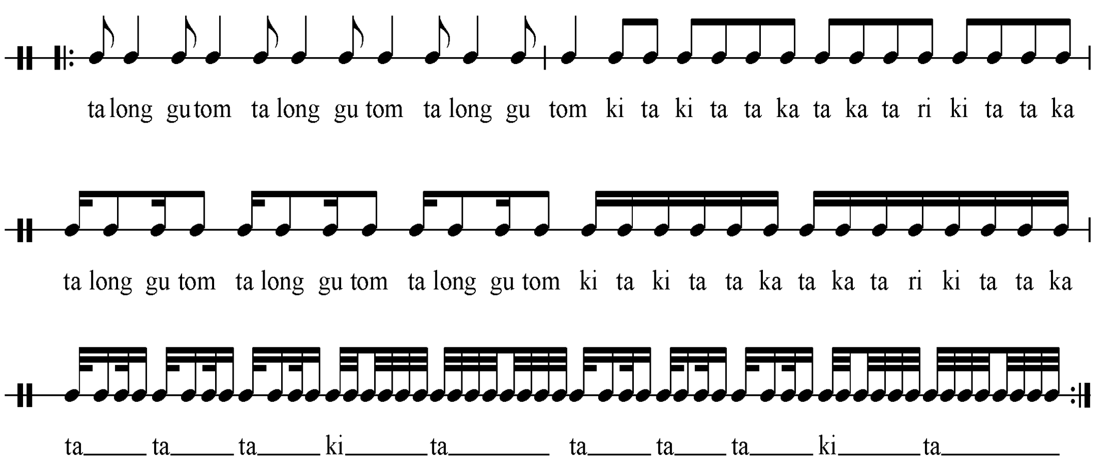


Lesson 6 in three speeds

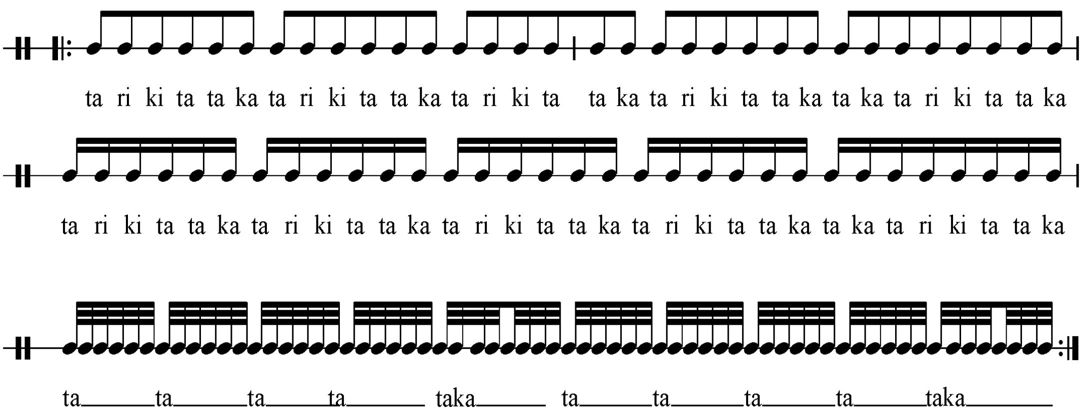


Lesson 7 in three speeds

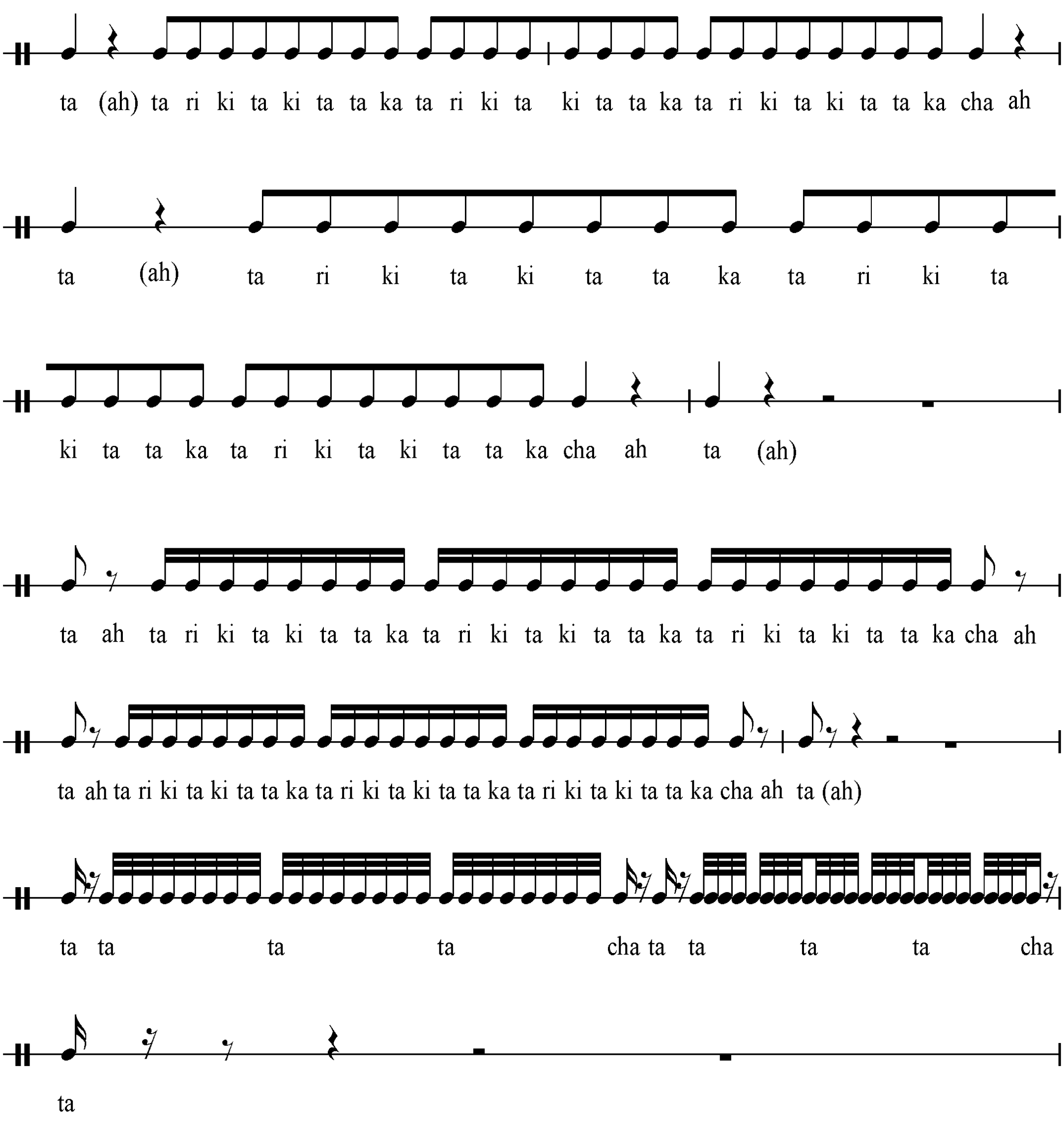
Lesson 8 in three speeds

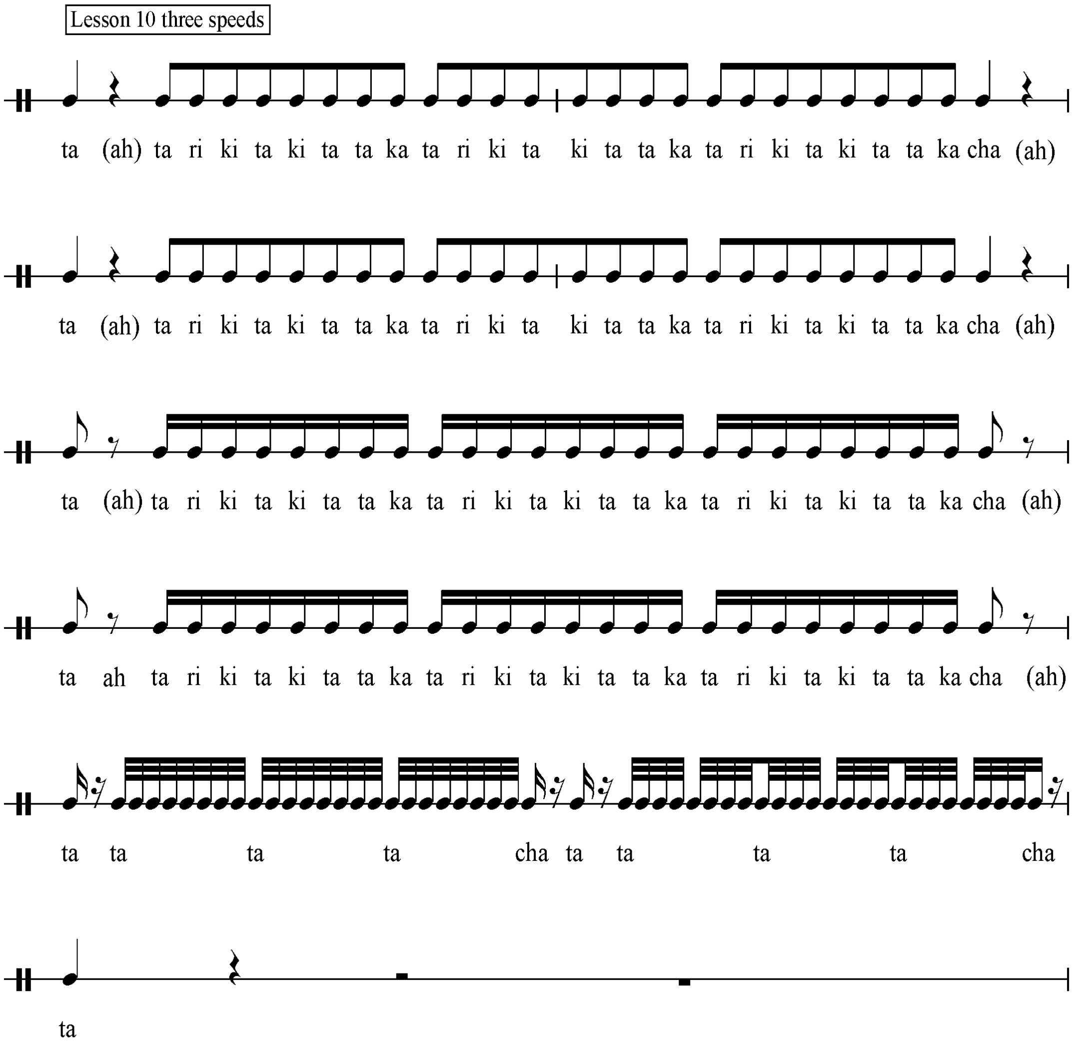


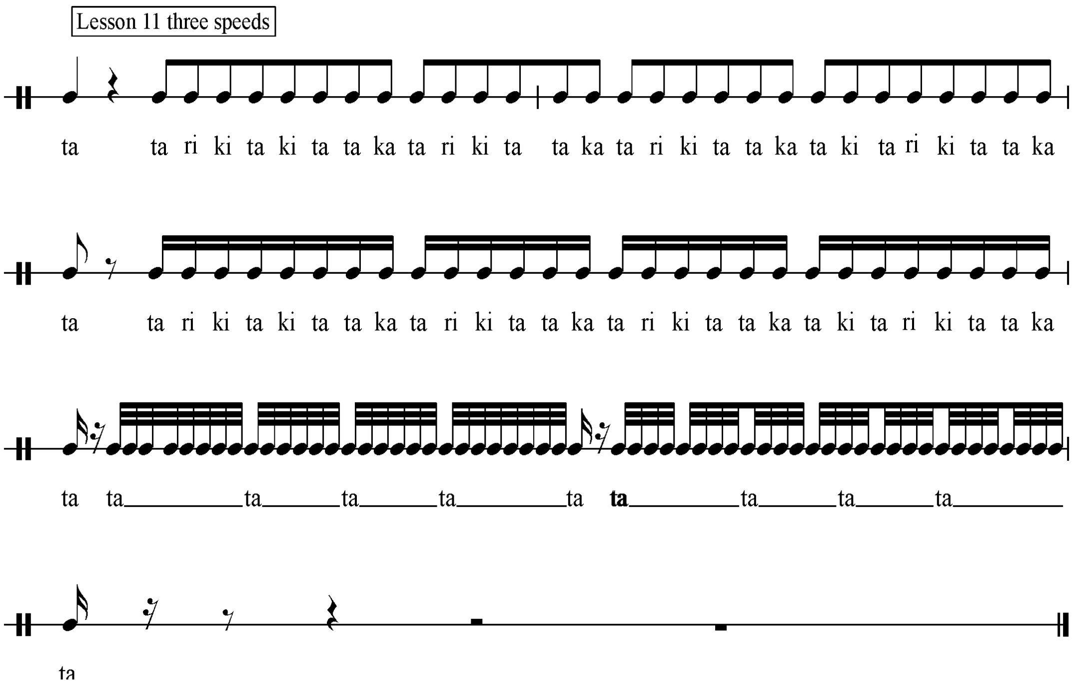
Lesson 9 three speeds



Lesson 10 three speeds



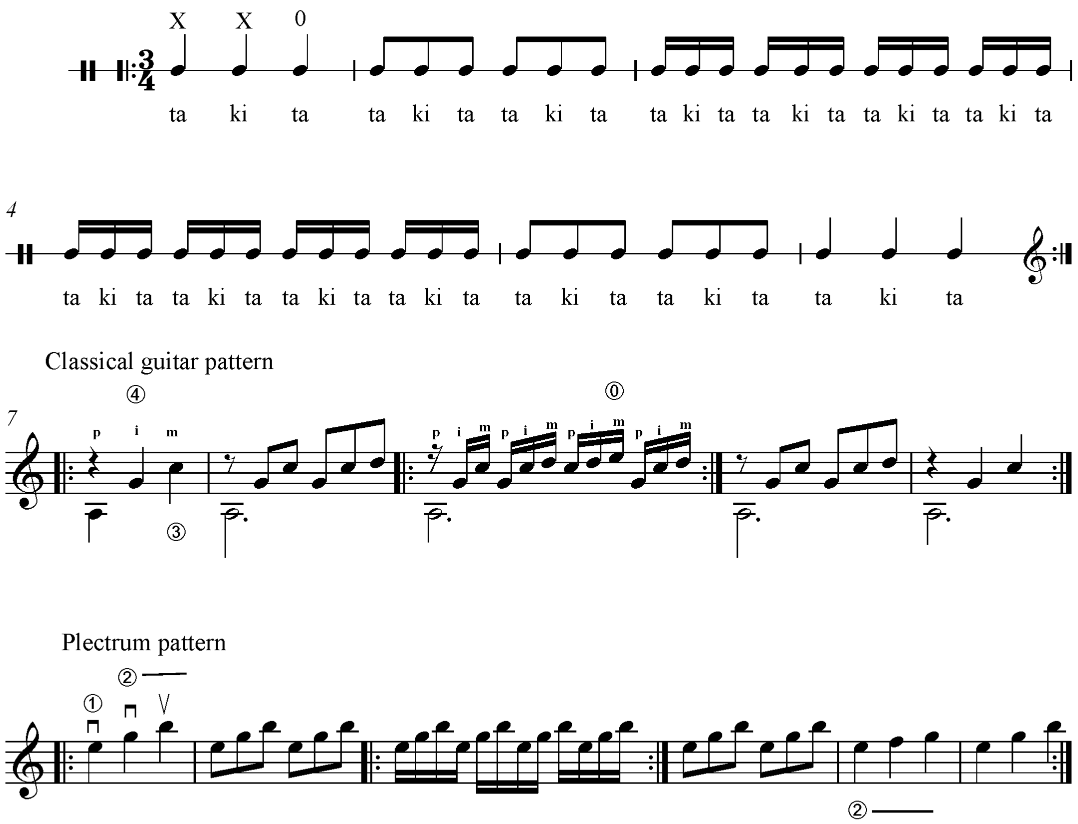

Lesson 10 three speeds
ta (ah) ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka cha (ah)
ta (ah) ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka cha (ah)
ta (ah) ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka cha (ah)
ta ah ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka ta ri ki ta ki ta ta ka cha (ah)
ta ta ta ta cha ta ta ta ta cha
ta


Lesson 11 three speeds
ta ta ri ki ta ki ta ta ka ta ri ki ta ta ka ta ri ki ta ta ka ta ki ta ri ki ta ta ka
ta ta ri ki ta ki ta ta ka ta ri ki ta ta ka ta ri ki ta ta ka ta ki ta ri ki ta ta ka
ta ta___ ta___ ta___ ta___ ta ta___ ta___ ta___ ta___
ta

3.4 Rupaka Tala

The following exercises 3.4 to 3.7 use rhythmic expansion, contraction and *nadai* within different *talas* or time signatures. In the *rupaka tala* exercise immediately below, the *konokol* pattern is in *tisra nadai,* the same as the time signature, 3.6 is also a good example of this this technique. However, the *nadai* does not have to be numerically the same as the *talam* and can be superimposed against as in the following *adi tala mora* using *khanda jati* 3.6*.* This demonstrates that all the following exercises can easily be transformed into new *tala, nadai* and *konokol* patterns with a few mathematical adjustments. Some of the following exercises include a guitar pattern, which can be played simultaneously while reciting the *konokol* pattern. This is a useful exercise that can highlight rhythmic inadequacies between the voice and one's instrument.

Rupaka Tala Exercise.

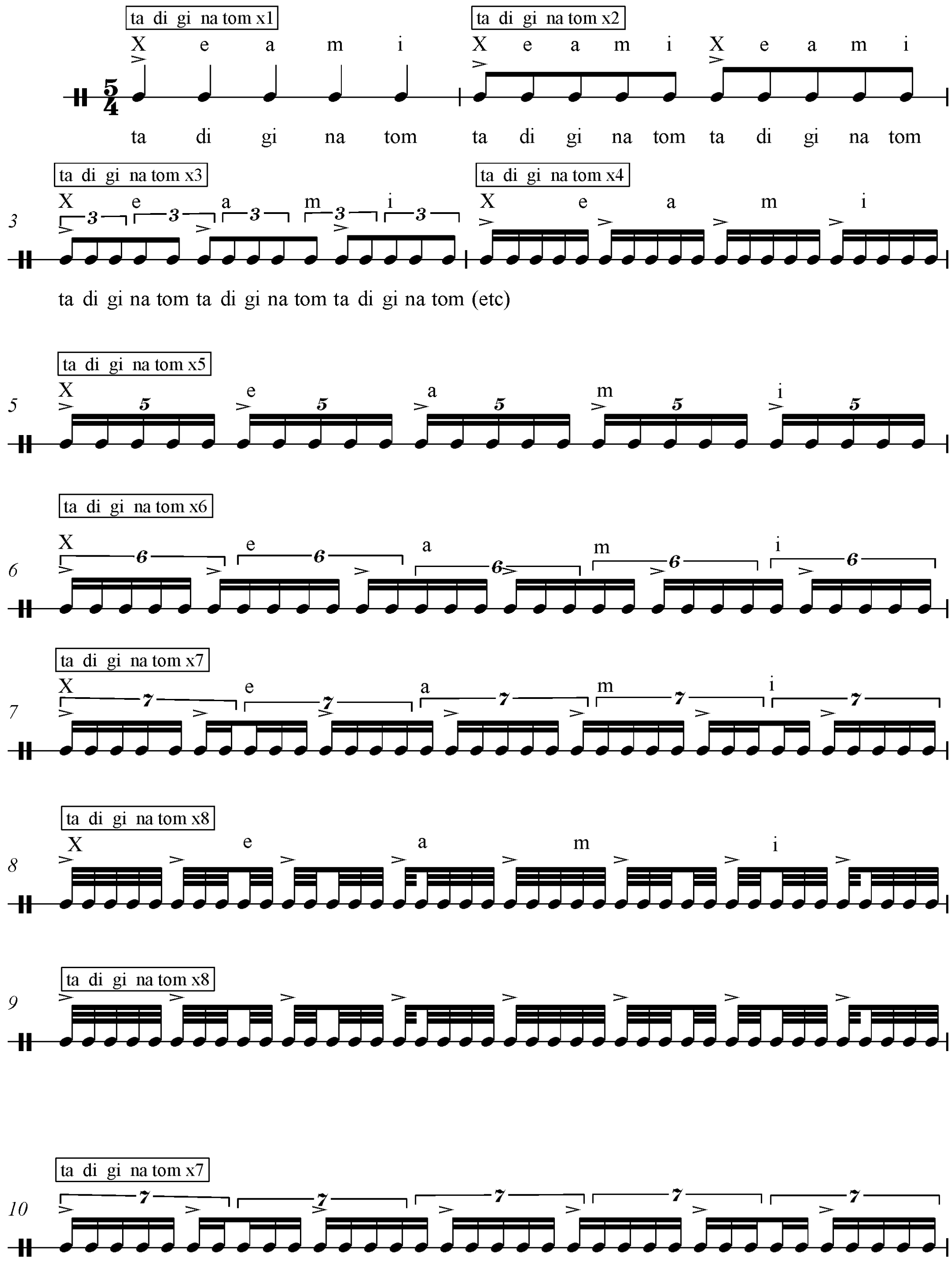


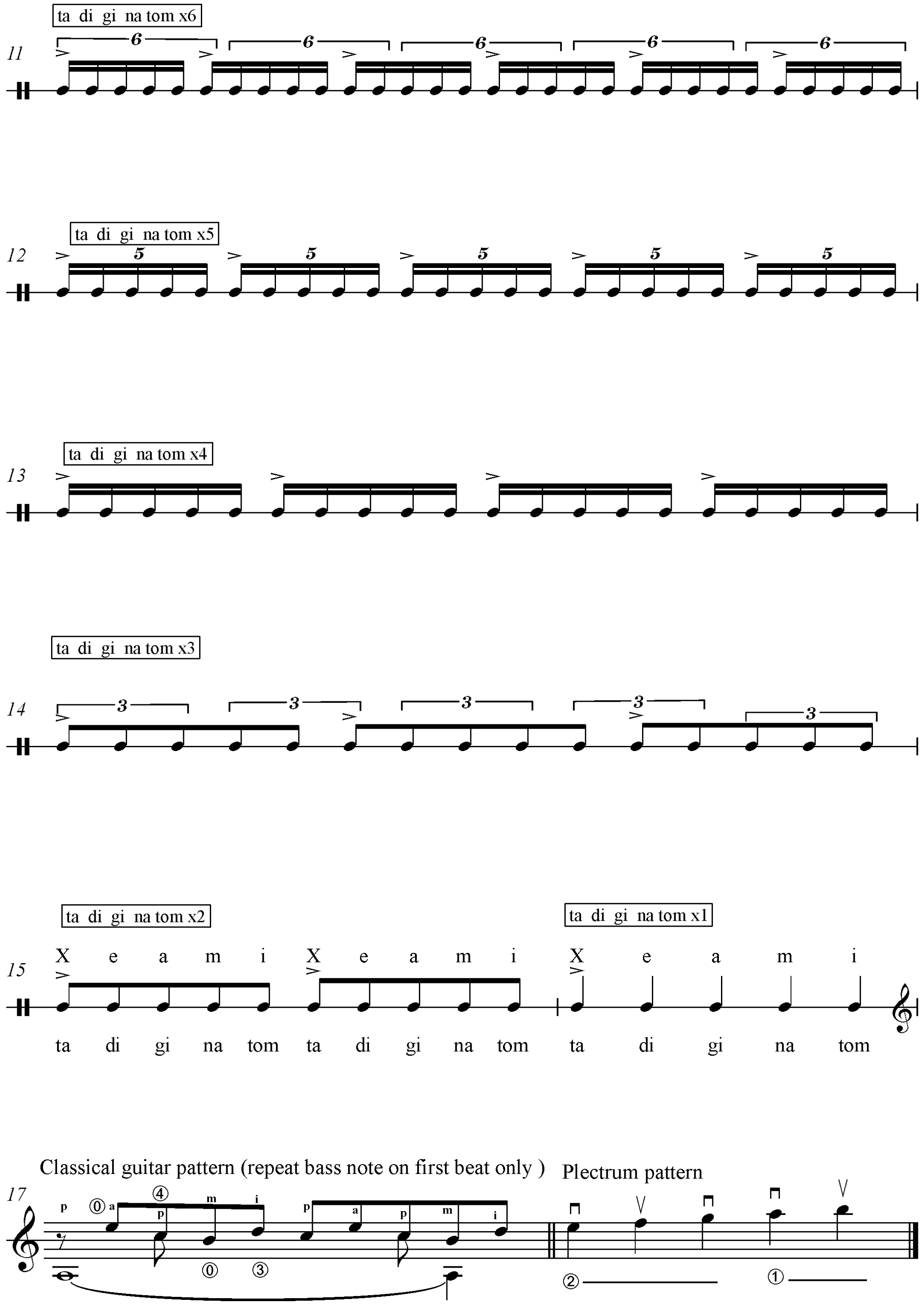
3.5 Mora in Adi Tala (Khanda Jati, Rhythmic Groupings in Five)

Mora in Adi Tala (Khanda Jati).

3.6 Khanda Eka Tala

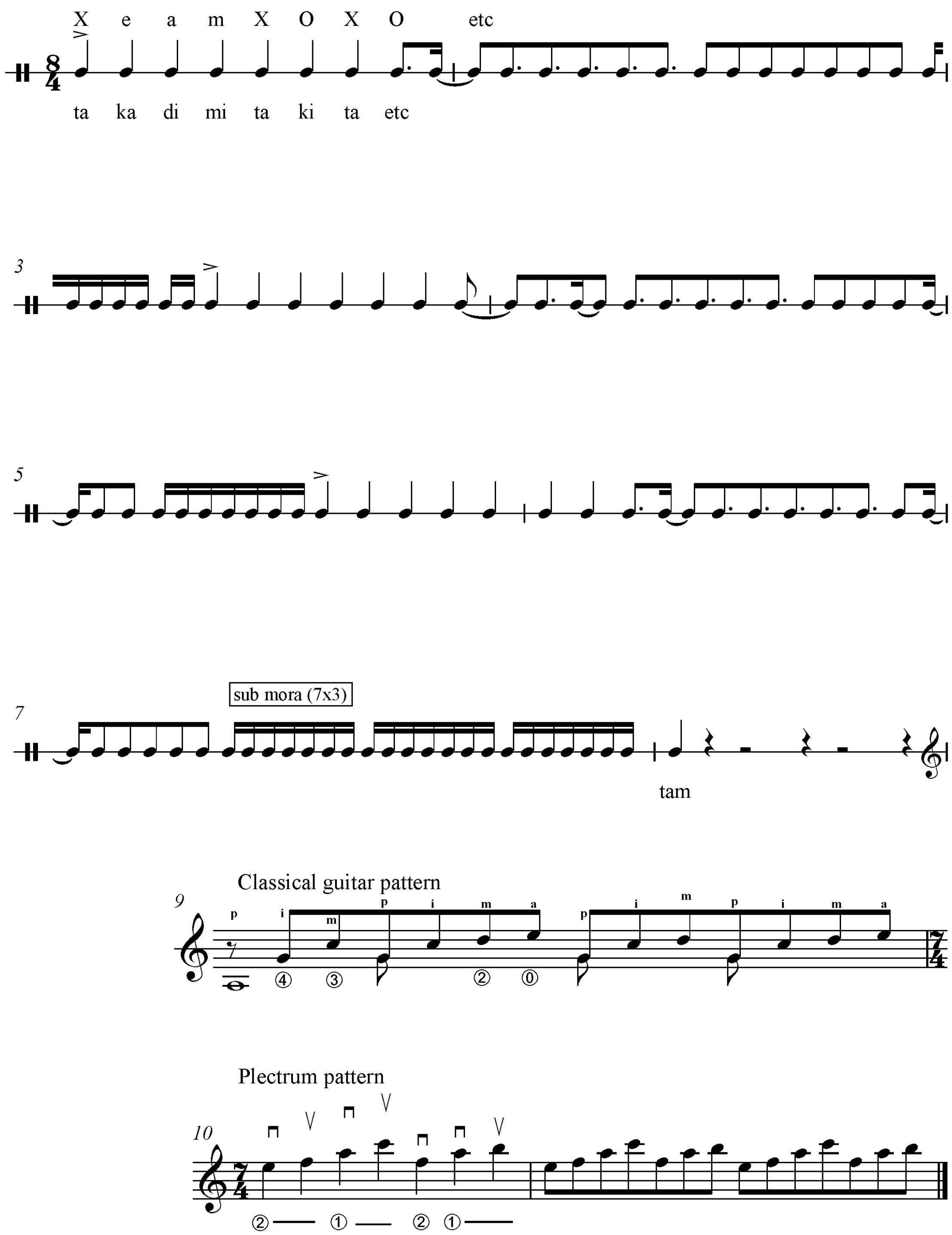
Khanda Eka Tala Exercise.




ta di gi na tom x6
11
6
ta di gi na tom x5
12
5
ta di gi na tom x4
13
ta di gi na tom x3
14
3
ta di gi na tom x2
ta di gi na tom x1
15
X e a m i X e a m i X e a m i
ta di gi na tom ta di gi na tom ta di gi na tom
Classical guitar pattern (repeat bass note on first beat only)
Plectrum pattern
17
p a p m i p a p m i

3.7 Mora in Adi Tala (Misra Jati, Rhythmic Groupings in Seven)

Mora in Adi Tala (Misra Jati).



3.8 Regrouping Exercises

1 = Ta (All syllables can represent any rhythmic duration)
2 = Ta ka
3 = Ta ki ta
4 = Ta ka di mi (Ta ka jo nu)
5 = Ta di gi na tom
6 = Ta ri ki ta ka (Ta di .gi na tom)
7 = Ta ka di mi ta ki ta (Ta . di. gi na tom)

Examples 1 and 2 below regroup different *konokol* syllables to achieve displaced accents in the second half of *adi tala* using *chatusra* and *tisra nadai*. Not all permutations and *yati* are listed here, as the rhythmic possibilities are endless. However, these two exercises should give an insight into its theoretical applications. The *konokol* used here is basic, but useful to instrumentalists because it opens up new syncopation sequences, which can easily be applied to melodic improvisation. The examples can also be practised in different *nadai* and syllables regrouped giving different accents. For example, *ta ka ta ka* is interchangeable with *ta ka di mi* and syllables can also be substituted for rests. When practising with rests, I would say the rest syllables just under the breath and eventually eliminate them completely. This can help with both feeling the rests and rhythmic accuracy. Henrik Andersen makes extensive use of these techniques in his book *Shortcut to Nirvana* (Andersen, 2004, p. 9).

3.8.1 Example 1: Regroupings in chatusra nadai

Chatusra Nadai									
X I I I X O X O									
4 Ta ka di mi	4 Ta ka di mi	4 Ta ka di mi	4 Ta ka di mi	3	3	2	3	3	2
				3	2	3	3	2	3
				2	3	3	2	3	3
				2	2	3	3	3	3
				3	2	2	3	3	3
				3	3	2	2	3	3
				3	3	3	2	2	3
				3	3	3	3	2	2
				2	3	3	3	3	2
				3	2	3	3	3	2
				5		5		3	3
				3	5		5		3
				3	3	5		5	
				5		3	3	5	
				7		7		2	
				2		7		7	
				7		2		7	

3.8.2 Example 2: Regroupings in tisra nadai

<table>
<tr><td colspan="9">Tisra Nadai</td></tr>
<tr><td colspan="9">X I I I X O X O</td></tr>
<tr><td rowspan="10">3
Ta ki ta</td><td rowspan="10">3
Ta ki ta</td><td rowspan="10">3
Ta ki ta</td><td rowspan="10">3
Ta ki ta</td><td>2</td><td>2</td><td>2</td><td>3</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>3</td><td>2</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>3</td><td>3</td><td>2</td></tr>
<tr><td>3</td><td>2</td><td>2</td><td>2</td><td>3</td></tr>
<tr><td>3</td><td>2</td><td>2</td><td>3</td><td>2</td></tr>
<tr><td>2</td><td>3</td><td>2</td><td>2</td><td>3</td></tr>
<tr><td>3</td><td>3</td><td>2</td><td>2</td><td>2</td></tr>
<tr><td>2</td><td>3</td><td>3</td><td>2</td><td>2</td></tr>
<tr><td colspan="2">7</td><td colspan="3">5</td></tr>
<tr><td colspan="2">7</td><td colspan="2">3</td><td>2</td></tr>
</table>

3.8.3 Example 3: Regrouping syllables

The following exercises are to be practised in *adi tala* in three different speeds, with a slight emphasis on *ta* and ending with *tam* to complete the cycle. The first exercise will take one cycle of *adi tala* in first speed, half a cycle in second speed and quarter of a cycle in third speed. Second and third speeds will need to be repeated to complete a full cycle of *adi tala*. Similarly, all the following exercises should be practised in different speeds and phrases that are repeated to fill up the *adi tala* cycle.

1 syllable per beat

0+	8	0	Ta ka di mi ta ka jo nu	= 8
1+	7	Ta +	Ta ki ta ta ka di mi	= 8
1+1+	6	Ta ta +	Ta ka ta ka di mi	= 8
1+1+1+	5	Ta ta ta+	Ta di gin a tom (ta ka ta ki ta)	= 8
1+1+1+1+	4	Ta ta ta ta+	Ta ka di mi	= 8
1+1+1+1+1+	3	Ta ta ta ta ta+	Ta ki ta	= 8
1+1+1+1+1+1+	2	Ta ta ta ta ta ta+	Ta ka	= 8
1+1+1+1+1+1+1+1	1	Ta ta ta ta ta ta ta+	Ta	= 8

2 syllables per beat

0	8+8	= 16
2+	7+7	= 16
2+2+	6+6	= 16
2+2+2+	5+5	= 16
2+2+2+2+	4+4	= 16
2+2+2+2+2+	3+3	= 16
2+2+2+2+2+2+	2+2	= 16
2+2+2+2+2+2+2	1+1	= 16

3 syllables per beat

0+	8+8+8	= 24
3+	7+7+7	= 24
3+3+	6+6+6	= 24
3+3+3+	5+5+5	= 24
3+3+3+3+	4+4+4	= 24
3+3+3+3+3+	3+3+3	= 24
3+3+3+3+3+3+	2+2+2	= 24
3+3+3+3+3+3+3+	1+1+1	= 24

4 syllables per beat

0	8+8+8+8	= 32
4+	7+7+7+7	= 32
4+4+	6+6+6+6	= 32
4+4+4+	5+5+5+5	= 32
4+4+4+4+	4+4+4+4	= 32
4+4+4+4+4+	3+3+3+3	= 32
4+4+4+4+4+4+	2+2+2+2	= 32
4+4+4+4+4+4+4+	1+1+1+1	= 32

3.8.4 Example 4: Polyrhythms

In Example 3 above, the metre comes from the value of the chosen *jati,* which is multiplied by *aksaras* per beat. If the metre is seven using *misra jati* and we use two *aksaras* per beat, the *jati* will be repeated twice before it resolves. If there are three *aksaras* per beat, the *misra jati* will be repeated three times before it resolves. The concept is generally repeated up to nine *aksaras* per beat and can be used in any time signature or *tala*. For example, all the following patterns will begin on beat two in both *adi tala* and 4/4 time. Exactly the same concept can be used and transferred into other *talas* or time signatures. It is a technique I partially explored in the improvisation section of *The Wait* for solo guitar. The following polyrhythmic exercises are useful for personal rhythmic development and are easily adapted to linear melodic playing and chordal accompanying.

Example 1: *Adi tala* 2+2+2 =3+3 = 6 or 3+3+3+3 = 4+4+4 = 12

X	**I**	**I**	**I**	**X**	**O**	**X**	**O**
Ta ka Ta Ta ri ki	ka Ta ka ta ta ka	Ta ka Ta Ta ri ki	ka Ta ka ta ta ka	Ta ka di	mi Ta ka	di mi Ta	ka di mi
6 syllable groupings against 4 beats 6:4				3 syllable groupings against 4 beats 3:4			

Example 2**:** *Khanda eka tala*, *jati* (ta di gin a tom) x 3

X	**I**	**I**	**I**	**I**
Ta di gi	na tom Ta	di gi na	tom Ta di	gi na tom
3 syllable groupings against 5 beats 3:5				

Example 3a: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 2

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka	di mi	ta ki	ta Ta	ka di	mi ta	ki ta
2 syllable groupings against 7 beats 2:7						

Example 3b: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 3

X	I	I	I	I	I	I
Ta ka di	mi ta ki	ta Ta ka	di mi ta	ki ta Ta	ka di mi	ta ki ta
3 syllable groupings against 7 beats 3:7						

Example 3c: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 4

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka di mi	Ta ki ta Ta	ka di mi ta	ki ta Ta ka	di mi ta ki	ta Ta ka di	mi ta ki ta
4 syllable groupings against 7 beats 4:7						

Example 3d: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 5

X	I	I	I	I	I	I
Ta ka di mi ta	ki ta Ta ka di	mi ta ki ta Ta	ka di mi ta ki	ta Ta ka di mi	ta ki ta Ta ka	di mi ta ki ta
5 syllable groupings against 7 beats 5:7						

Example 3e: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 6

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka di mi ta ki	ta Ta ka di mi ta	ki ta Ta ka di mi	ta ki ta Ta ka di	mi ta ki ta Ta ka	di mi ta ki ta Ta	ka di mi ta ki ta
6 syllable groupings against 7 beats 6:7						

Example 3f: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 7

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka di mi ta ki ta	Ta ka di mi ta ki ta	Ta ka di mi ta ki ta	Ta ka di mi ta ki ta	Ta ka di mi ta ki ta	Ta ka di mi ta ki ta	Ta ka di mi ta ki ta
7 syllable groupings 7 beats 7:7						

Example 3g: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 8

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka di mi ta ki ta Ta	ka di mi ta ki ta Ta ka	di mi ta ki ta Ta ka di	mi ta ki ta Ta ka di mi	ta ki ta Ta ka di mi ta	ki ta Ta ka di mi ta ki	Ta Ta ka di mi ta ki ta
8 syllable groupings against 7 beats 8:7						

Example 3h: *Misra eka tala, jati* (ta ka di mi ta ki ta) x 9

X	**I**	**I**	**I**	**I**	**I**	**I**
Ta ka di mi ta ki ta Ta ka	di mi ta ki ta Ta ka di mi	ta ki ta Ta ka di mi ta ki	ta Ta ka di mi ta ki ta Ta	ka di mi ta ki ta Ta ka di	mi ta ki ta Ta ka di mi ta	ki ta Ta ka di mi ta ki ta
9 syllable groupings against 7 beats 9:7						

3.9 Korvai

Korvai is an important cadential form usually complex in structure. It uses various phrase structures arranged in a sequential order in the model of a *yati,* discussed in Chapter 2. *Korvais* are usually binary in form and often include a *mora.* A *korvai* is usually played *three times* in sequential order, sometimes with variations after each repetition. This *korvai* with repetitions in *chatusra nadai adi tala* will take 4.5 cycles to complete.

If this *korvai* is played once in *adi tala*/8/4 in quarter notes, it will take six cycles to complete, in quavers three cycles, in semiquavers 1.5 cycles, in triplets two cycles, and in semiquaver triplets one cycle. Each of the above cycles can be repeated three times or once with the *sam* and starting point remaining the same. For example, the *chatusra nadai korvai* below will start at the halfway point, regardless of whether it is repeated once or three times, in *tisra nadai* it will begin and end on *sam* . In either case, it is important that the *korvai* resolves on the *sam*: this means that the stating point will be different depending on the *nadai.*

***Chatusra nadai* (One repetition = 1.5 cycles, three repetitions = 4.5 cycles)**

Ta ki ta ta ki ta ta ka di mi ta . ta = 13
ta ki ta ta ka di mi ta . ta = 10
ta ka di mi ta . ta =7
ta . ta =3 Total= 33 *Gopucca yati*

Ta di gi na tom
Ta di gi na tom
Ta di gi na tom || Ta = 15 *Sama yati* = 48 (1.5 cycles in *adi tala*)

***Tisra nadai* (One repetition = 2 cycles, three repetitions = 6 cycles)**

Ta ki ta ta ki ta ta ka di mi ta . ta = 13
ta ki ta ta ka di mi ta . ta = 10
ta ka di mi ta . ta = 7
ta . ta = 3 = 33 *Gopucca yati*

Ta di gi na tom
Ta di gi na tom
Ta di gi na tom || Ta = 15 *Sama yati* = 48 (2 cycles in *adi tala*)

The *Ta di gi na tom* family of rhythms feature throughout Chapter 3. *Ta di gi na toms* also feature in the construction of *moras* and *korvais* as well as dance compositions and *thani avartanam*. Chapter 4 is dedicated to the *Ta di gi na tom* family of rhythms and how they can be used in composition and improvisation.

Chapter 4: The Application of the Ta Di Gi Na Tom Family of Rhythms to the Classical and Plectrum Guitar.

4.1 Introduction to Ta Di Gi Na Toms and Cyclic Form

The key to understanding *ta di gi na toms* and Carnatic rhythm are its mathematical structures (see Appendix A). I began by examining *ta di gi na toms* musically and from an ethnographic perspective. The concepts that stand out for me that relate to Carnatic music is the concept of infinity in the Hindu religion, the development of the 10-base system and the concept of zero, all of these concepts have been highly developed in Indian culture. Carnatic music embraces these concepts in its theory and practice, the combination of which encapsulates a philosophy that extends beyond what the performer can physically express on an instrument (Clayton, 2008, p. 16). Mathematics, the concept of zero, nothingness and infinity are embedded in Indian culture and thought. In Indian music, these ideas extend back to Vedic hymns that expressed in symbolic form an existence beyond the given datum: a symbolic form that developed through history and experience into the present and which continues to grow (Mohanty, p. 127).

The *ta di gi na tom* family of rhythms are a fundamental building block of Carnatic music and are one of the first rhythmic concepts taught to percussion students (Sankaran, 2010, p. 6). *Ta di gi na toms* are used in all aspects of Carnatic music, including ensemble and solo playing, improvisations, accompaniments, *mukthayams*, *moras* and *korvais*. Percussionists also use *ta di gi na toms* as a compositional device to construct *thani avartanum*. Every rhythmic manipulation and mathematical permutation of the *ta di gi na tom* family has been examined in Carnatic music. In this Chapter I have only dealt with the concept primarily in one speed and *nadai*; however, it is learned in three speeds, in *nadai 4, 3, 5, 7 and 9,* and in rhythmic groupings of 5, then 6, 7, 8, 9 and 10 by adding rests between the syllables. My teacher Vidwan Bangalore Amrit suggested learning *ta di gi na toms* as *konokol* patterns in *adi tala* with the appropriate hand gestures before applying them to my instrument. Amrit suggested this process because it facilitates rhythmic isolation through a well-established pedagogical process (see Appendix A).

Indian thought, music, philosophy and religion extend to concepts of infinity, cosmic time and beliefs, beyond phenomenal being (Clayton, 2008, p. 16–18). Indian music is no exception, the *ta di gi na tom* family represents a methodology that is not an idea signifying recurrence or finality but an endlessly variable set of rhythmic cadential possibilities.

South Indian percussion performance practice has continually built upon particular mathematical sequences and musical structures through a collective consciousness. Carnatic music involved expressing every possible number using a set of 10 symbols, with each symbol having a place value and an absolute value (Benjamin, 2007, p. 10). The development of these mathematical possibilities and the idea of the infinite had a great impact on Indian cultural practices, with particular musical forms and mathematical patterns becoming popular over time. The relationship between mathematics and Western music, however, was focused on ratio and harmony not linear rhythm. It is primarily rhythm and pulse that has a deep relation to rhythmic bodily movement; hence, the highly developed system of *tala* gestures and *konokol* help facilitate this relationship in the body—a system that does not exist in Western music.

It is important in a Carnatic ensemble to understand *ta di gi na toms* so that phrases can be played in unison spontaneously or variations can be played on predetermined and learnt calculations. An individual can easily utilise these concepts as an improvisatory tool, but as complexity grows so does the need for a shared musical language.

4.2 Learning Ta Di Gi Na Toms and Incorporating Them into Your Music

My first step towards learning *konokol* was to learn the *adi tala* cycle with appropriate hand movements, then to vocally recite *ta di gi na toms* from 5 through to 10, eventually putting *tala,* clapping and vocals together. *Ta di gi na toms* of 5, 6, 8 and 10 should be practised first because 9 and 7 are more difficult. The great advantage of *konokol* is that it can be practised away from the instrument anywhere anytime, eventually ingraining these rhythms into one's vocabulary and then onto one's chosen instrument. How *ta di gi na toms* are used on an instrument depends on the creativity of the individual, (see Appendix A).

4.3 Mukthayam and Ta Di Gi Na Tom Considerations

1. Use short *mukthayams* to begin with because they are easier and more practical when improvising with harmony.
2. Use *mukthayams* to extend compositional structures.
3. Use *mukthayams* as simple accompaniment patterns.
4. Use *mukthayams* in solo contexts.
5. Use *mukthayams* to construct single melodic lines.
6. Use *mukthayams* in differen*t nadai* and *yati* patterns.
7. String a series of *mukthayams* together in a *yati* pattern.
8. When using *mukthayams* and harmony, consider not using harmonic rhythm; instead change the time signature to suite the *mukthayam*.
9. Improvise to a drone and end all phrases with a *mukthayam* landing on the *sam.*

4.4 Plectrum Guitar and Ta Di Gi Na Toms

I have applied the *ta di gi na tom* family of rhythms to the guitar in two different ways. The first is for classical guitar improvisation, accompaniment patterns and chord sequences (Towner, 1985, p. 18). The second is for plectrum guitar using a more traditional linear melodic approach (see Appendix A).

In the linear plectrum *ta di gi na toms*, I have used a sweeping guitar technique because of the odd number of notes. I found this especially helpful at fast tempos and it keeps the plectrum technique and phrasing articulated in groups of five. This same technique applies to all the variations of *ta di gi na toms*. The alternative to this is alternate picking. This is also good but when I started on a down stroke on the first *ta di gi na tom,* the second *ta di gi na tom* became an upstroke: this became problematic when trying to phrase evenly. Usually, this applies to guitar players who have a weak upstroke. If this is the case, then *ta di gi na toms* will be difficult to play. Alternate plectrum playing is often associated with harmonic rhythm in Western music, which generally places emphasis on down strokes in relation to harmonic context. However, Django Reinhardt is a great example of down stroke combined with sweeping guitar techniques.

My observation of many Asian and Middle Eastern plectrum techniques is of the use of rest strokes and variations of alternate and directional picking. The unevenness evident in Western plectrum guitarists is a result of unconsciously playing to harmonic rhythm—that is, strong weak, strong weak in relation to harmonic dissonance and consonance. In jazz, I was taught to bring out dissonance (up stroke) and resolve it to consonance (down stroke); this picking can bring about uneven picking. Gypsy guitarists, however, use the effects of gravity on a bent right-hand wrist to make down strokes strong. This is not a criticism of alternate picking as it functions perfectly well for improvisation in most Western tonal music contexts. However, in Indian music, there is no such thing and the strong weak idea can be anywhere except for the *sam,* which is usually strong. For example, in *adi tala, ta di gi na toms* can be repeated in semiquavers in succession and this can start to sound like 15/16. I found when changing harmony is absent, this allowed extended linear rhythmic complexity to continue more easily. This is not to say that this phrasing is not used in Western improvisation, it is, but to a more limited extent because, as harmony changes, it also effects linear rhythm, phrasing and articulation.

Rhythm is not a fundamental principle in learning and playing Western improvised and classical music. The limited rhythmic concepts one learns as a Western musician (i.e., 1 e and a 2 e and 3 e and a …) and the 'French time names' are a testament to this. There are many complex rhythms in Western music. However, Western musicians generally learn rhythm through specific repertoires rather than a separate and dedicated rhythmic pedagogy. This is not so with South Indian music: all rhythmic permutations can be expressed in *konokol*. My observation from attempting to express *konokol* in Western music is that the bar line and harmony conflict with linear rhythmic complexity and, consequently, can limit its development to a degree. The question is: How can South Indian rhythmic ideas be incorporated in a meaningful way into Western improvisation and does harmony really restrict the use of complex linear rhythmic concepts in Western music?

4.5 The Classical Guitarist's Right Hand and Ta Di Gi Na Toms

For the classical guitar, I have treated each string like a drum, mapping the sounds of the *mrdangam* to individual guitar strings. The transference of these ideas is quite idiomatic and natural, allowing the classical guitarist to utilise a vast number of linear arpeggio techniques that work across the strings. These techniques allow great flexibility in both interacting and accompanying a soloist compared with the techniques of a plectrum because of the rhythmic flexibility of the right-hand fingers. These techniques are also very useful in solo guitar playing. Ralph Towner makes extended use of a similar polyrhythmic technique in his playing, although he resolves his polymetrical ideas through his musical ability and intuition rather than a systematic theory of cadential formulas (Towner, pp. 1–81). In saying this, his book *Improvisation and Performance Techniques for Classical and Acoustic Guitar* is clearly influenced by Indian rhythms and is a very original approach to improvising on the classical guitar (see Appendix A).

The application of *mukthayams* combined with *ta di gi na toms* to the guitar depends on technique and playing style. Chapter 4 outlines how I have thought about intuitively applying these ideas to guitar techniques also making reference to guitarist composers who have influenced this intuition (see Appendix A). In Chapter 5, I have outlined *mukthayams* and the *ta di gi na tom* family of rhythms in a more theoretical way which allowed me the possibility to explore technical approaches to the guitar through mathematics alone. My methodological approach in Chapter 5 was to document, reference and explore the creative, theoretical possibilities using *mukthayams* and *ta di gi na toms* through mathematics a priori.

Chapter 5: Mukthayam Graphs

The *mukthayam* graphs in Chapter 5 outline the possible *mukthayams* in the tala/signatures of 3/? 4/? ,5/?, 6/?, 7/?, 8/?, 9/?, with the lower denominator being interchangeable. The subdivisions/*nadai* I have used in the graphs use 2-9 *aksharas* per beat (see Appendix B).

5.1 How to Use Mukthayam Graphs

A *mukthayam* is an important rhythmic cycle repeated three times, creating tension and landing on a fixed point, the *sam*, usually the first beat of a *tala* cycle. In North India, the last note of the very last phrase is the *sam,* in South India the last note of the last phrase is usually just before the *sam* and an extra note added to complete it (although both forms exist in Carnatic music). For example, (*ta di gi na tom*) x 3||*Tam*: *tam* is added to land on *the sam* but is not symmetrically part of the *ta di gi na tom* phrases. This created difficulty for me when composing symmetrical melodies because I had to add an extra note (musically, the phrase ends on *the sam* but phonetically is does not). The graphs (see Appendix B), are from the South Indian tradition, but if these *mukthayams* are moved one pulse forward they can be used as a North Indian *tihai.* I created these graphs to be a practical guide to find suitable *mukthayams* for improvisation and composition and to display the many possible mathematical combinations of *mukthayams.* Modally or with simple harmony, short *mukthayams* will work well. The application of complicated harmony and longer *mukthayams* will need some experimentation.

In Appendix B you will find 42 *mukthayams* and their corresponding gaps in seven different time signatures or *talas.* Gaps are sometimes used in *mukthayams* when the number you are dealing with is not divisible by three. For example, 83 is not divisible by 3, 82 is also not divisible by 3, but 81 divided by 3 is 27. To make up a *mukthayam* of 83, we can have (27 + 1 gap) + (27 + 1 gap) + 27 = 83.

Using this calculation will help fill the required ending in a composition or improvisation. The length of the gap and the *mukthayam* will depend on the composition and the improviser's imagination. An important factor is knowing how many cycles and divisions of the beat you are dealing with. The cycles that are not relevant in these graphs are crossed out but are added for the sake of completion. Creating the examples below gave me many ideas on how these tables and graphs can be used. Although I have not finished exploring how to use these *mukthayam* graphs, I propose there are many ways to use them, depending on the application. There are mathematical patterns in the graphs that could generate some rhythmically creative outcomes. For example, if I want to fill one bar of 4/4 time with a *mukthayam* of 5 in any *nadai* with or without gaps, there will be 14 possibilities, 1 in graph 27, 3 in graph 28 and 5 each in graphs 29 and 30. As long as the total of the *mukthayam* and the gap before it does not add up to more than one cycle, I can use it.

5.1.1 Example 1 in adi tala

In order to construct a *mukthayam* three things need to be known: the time cycle, *nadai* and *mukthayam*. This construction of a *mukthayam* involves a four-step process. For example, if we have a time signature of 8/4 (adi tala) and we want to create a *mukthayam* in 5 with 4 pulses per beat and I want to find this *mukthayam* in Appendix B, the process would be as follows.

1. Find *mukthayams* in groups of 5, limited to graphs 25–32.
2. Find 4 pulses per beat in groups of 5 (*chatusra nadai*), limited to graph 27.
3. Find 1 cycle in 8/4 in semiquavers = 32 subdivisions, limited to 2 cycles.
4. Find (Gap = 17) + (mukthayam = 15) = 32 subdivisions.

Example 1 continued in *Konokol*

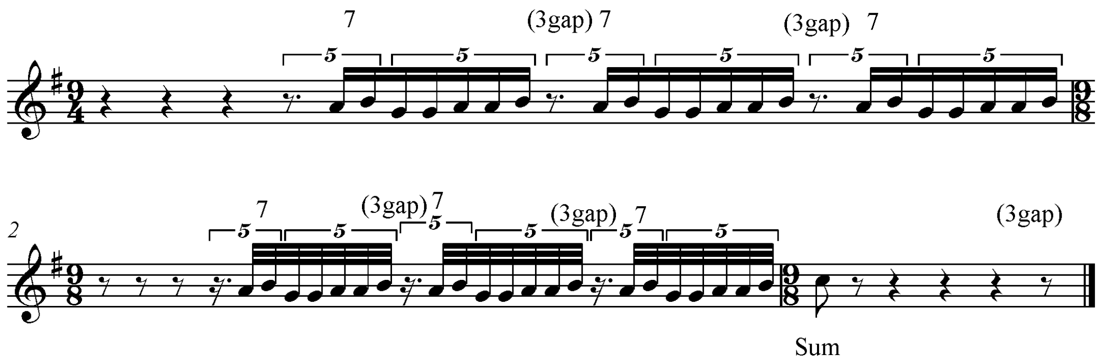
Ta ka di mi
Ta ka jo nu
Ta ka di mi

Ta ki ta ta ka **or** (*ta ka jo nu .*) Gap = 17 + (*ta di gi na tom*) x 3 *mukthayam* = 32||*Sam*

5.1.2 Example 2 in *Sankirna eka tala*

If we have a time signature of 9/? (*Sankirna eka tala*) and we want to create a *mukthayam* in quintuplets that uses groups of 7 + 3 *karvai*:

1. Find *mukthayams* in groups of 7 with a gap of 3, limited to graphs 41–48.
2. Find 5 pulses per beat, limited to graph 44.
3. Find 1 cycle in 9/4 or 9/8 in = 45 subdivisions, limited to graph 44, column (9/a).
4. Find (Gap = 18) + (*Mukthayam* = 27) = 45 Subdivisions, 27 is also divisible by 3, so there is the option of a *mukthayam* of 9 + 9 + 9.



Example 2 in *Konokol Sankirna eka tala*

X	I	I	I	I	I	I	I	I	X
			… ta ka	di mi ta ki ta	… ta ka	di mi ta ki ta	… ta ka	di mi ta ki ta	Ta
									Sam

5.1.3 Example 3 in poorvanga and utharaanga

Poorvanga and *utharaanga* are two sections that make up a *korvai*; each has a *mora/mukthayam* structure, but *utharaanga* has no gap after the last repeat. If you wanted to add two *mukthayams* together to make up a total *tala* cycle in *adi tala* using conventional *korvai* construction with four *aksaras* per beat, it would be done in the following manner (see Table 1 below: see also Chapter 3, Section 3.9). Note that in *korvais* there can be a gap after the third repeat in *poorvanga* and no gap after the third repeat of *utharaanga* (see Table 1). Both *poorvanga* and *utharaanga* can be repeated three times and can subsequently be further divided into further *mukthayams,* especially when dealing with larger numbers. The idea of these tables evolved from a blog discussion with Balaji (2014).

Table 1: Constructing a *korvai* using *poovanga* and *utharaanga.* Once combined, it can be repeated three times

Poorvanga	***Utharaanga***
Divisible by 3 with or without *karvais*	Divisible by 3 with or without *karvais*
5 + 5 + 5 = 15	5 . 5. 5 = 17 no *karvai* on last repeat (3 + 2.) + (3 + 2.) + (3 + 2)
15 + 17 = 32. One cycle of *adi tala* or two bars of 4/4	

Poorvanga	***Utharaanga***
Divisible by 3 with or without *karvais*	Divisible by 3 with or without *karvais*
27	37
$6^3 6^3 6^3 = 27$	$9^5 9^5 9 = 37$ no *karvai* on last repeat
27 + 37 = 64 Two cycles of *adi tala* or four bars of 4/4	

I found the easiest way to construct a *korvai* was to devise my own numerical table for the appropriate time signature or *tala*. With a different time signature and *nadai,* a new table will obviously need to be constructed as new numerical patterns develop (see Table 2).

Table 2: Possible combinations of 39 *poorvanga* and 25 *utharaanga* highlighted in red: any two combinations of 39 and 25 will work together

***Poorvanga Adi Tala* 8/4 or 4/4**												
Gaps karvai		1	2	3	4	5	6	7	8	9	10	11
1	3	6	9	12	15	18	21	24	27	30	33	36
2	6	9	12	15	18	21	24	27	30	33	36	39
3	9	12	15	18	21	24	27	30	33	36	39	42
4	12	15	18	21	24	27	30	33	36	39	42	45
5	15	18	21	24	27	30	33	36	39	42	45	48
6	18	21	24	27	30	33	36	39	42	45	48	51
7	21	24	27	30	33	36	39	42	45	48	51	54
8	24	27	30	33	36	39	42	45	48	51	54	57
9	27	30	33	36	39	42	45	48	51	54	57	60
10	30	33	36	39	42	45	48	51	54	57	60	63

Example: Row $(2^1) = 2^{+1} + 2^{+1} + 2^{+1} = 9$, $(2^2) = 2^{+2} + 2^{+2} + 2^{+2} = 12$ etc.

***Utharaanga Adi Tala* 8/4 or 4/4**												
Gaps Karvai		1	2	3	4	5	6	7	8	9	10	11
1	3	5	7	9	11	13	15	17	19	21	23	25
2	6	8	10	12	14	16	18	20	22	24	26	28
3	9	11	13	15	17	19	21	23	25	27	29	31
4	12	14	16	18	20	22	24	26	28	30	32	34
5	15	17	19	21	23	25	27	29	31	33	35	37
6	18	20	22	24	26	28	30	32	34	36	38	40
7	21	23	25	27	29	31	33	35	37	39	41	43
8	24	26	28	30	32	34	36	38	40	42	44	46
9	27	29	31	33	35	37	39	41	43	45	47	49
10	30	32	34	36	38	40	42	44	46	48	50	52

Example: Row (31) = 3+ 1 + 3 + 1 +3 = 11, (32) = 3 + 2 + 3 + 2 + 3 = 13, (35) = 3 + 5 + 3 + 5 + 3 = 19

5.1.4 Example 4, Possible combinations for poorvanga 39 and utharaanga 25

The combination of two random numbers of 39 *poorvanga* + 25 *utharaanga* = 64 this equals two cycles of *adi tala*. Table 3 outlines all possible combinations for the 64 aksharas. Taken from the tables above, these can be paired with each other in various ways, always adding up to 64 *aksaras*.

Table 3: An easier representation of the possibilities of 39 *poorvanga* and 25 *utharaanga*

***Poorvanga* 39 +**	***Utharaanga* 25 = 64**
$2^{11}2^{11}2^{11}$	N/A
$3^{10}3^{10}3^{10}$	$1^{11}1^{11}1$
$4^{9}4^{9}4^{9}$	$3^{8}3^{8}3$
$5^{8}5^{8}5^{8}$	$5^{5}5^{5}5$
$6^{7}6^{7}6^{7}$	$7^{2}7^{2}7$
$7^{6}7^{6}7^{6}$	N/A
$8^{5}8^{5}8^{5}$	N/A
$9^{4}9^{4}9^{4}$ etc.	N/A

Gaps do not have to be defined as gaps and can be filled in with rhythms or syllables and divided further into groups of three or other combinations. In Chapter 3 of *The Solkattu Manual,* David Nelson explains the full construction of a *korvai* with its additional set-up (Nelson, 2008, p. 61). Nelson also suggests the longer a *korvai* becomes, the less tastefully it can be used in improvisation: long *korvais* are best suited to predetermined compositional structures. *Korvais Made Easy* by Hariharan is a very detailed study of *korvais* in every conceivable *nadai*. However, only the total number of the *korvai* is given and the internal *korvai* structure is left up to the performer to decide (Hariharan, 2004, pp. 3–163). The idea of these tables evolved from a blog discussion with Balaji (2014).

5.2 Tintal and Tihai Table in Odd Numbers

According to Narasimhan (1999, p. 78) a *tihai* is a final phrase played three times to arrive at the *sam*. I find *tihais* for instrumentalists very satisfying to play because the phrase is repeated ***exactly*** three times with the very last note of the last note landing on the *sam*. Using *mukthayams* melodically, however, adds an extra beat to land on the *sam*, which can disrupt melodic contour for an instrumentalist. For example, in (*ta gi gi na tom*) x 3||*Tam*, '*tam*' is the *sam* and is not phonetically part of the *ta di gi na tom* phrases. However, both forms exist in Carnatic music. North Indian music has a very strong instrumental tradition where *tihais* prevail. From my experience in South India, the vocal is stronger than the instrumental tradition where percussionists primarily use *mukthayams.* Historically, these two traditions have favoured different rhythmic calculations. However, I hear more *tihais* than *mukthayams* in the music of many Western instrumentalists (as in the music of John McLaughlin) who has studied both Carnatic and Hindustani music. This would need more research for an exacting answer as to why; despite this, I find *tihais* more natural to perform melodically.

I have included only prime numbers in the table of *tihais* (see Table 5) because they offer some interesting syncopations. I also wanted to find out why some *tihais* are used more than others. For example, the *tihai* 11 x 3 can be played at the beginning of the 1st, third and fourth *tintal* cycle and on the 1st beat in 4/4 time, even when rhythmically augmented or diminuted; this flexibility is probably the reason it is used so much (see Table 5). I have also outlined the different parts of *tintal,* as this is the most common *tala* in Hindustani music (see Table 4). The key to understanding *tala* in Hindustani music for an instrumentalist is focusing on the different divisions and hearing the *khali bols,* which are dampened. The different *divisions* of *tintal,* including *khali, matra*, *vibhag, tali* and *sam,* orient the performer both rhythmically and melodically, all of which are indicated by the *bols* of the tabla player. I have cross-referenced these *tihais* for usage in both Western and Indian contexts, albeit without a good knowledge of raga and tabla *bols.* However, these tables are limited in Indian performance practice but still useful in Western improvisation and composition. The following tables 4 and 5 demonstrate the cyclic form of *tintal* and *tihais* in prime numbers outlined in both 4/4 time and *tintal.*

Table 4: Cyclic form of *tintal* marking the important divisions. Red numbers indicate *vibhag* divisions and important numbers to remember when calculating rhythmic cadences

Sam	**Beats**														
(65)	66	67	68	**(69)**	70	71	72	**(73)**	74	75	76	**(77)**	78	79	80
(49)	50	51	52	**(53)**	54	55	56	**(57)**	58	59	60	**(61)**	62	63	64
(33)	34	35	36	**(37)**	38	39	40	**(41)**	42	43	44	**(45)**	46	47	48
(17)	18	19	20	**(21)**	22	23	24	**(25)**	26	27	28	**(29)**	30	31	32
(1)	2	3	4	**(5)**	6	7	8	**(9)**	10	11	12	**(13)**	14	15	16
	Bols														
dha	dhin	dhin	dha	dha	dhin	dhin	dha	dha	tin	tin	ta	ta	dhin	dhin	dha
matra	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*	*matra*
Vibhag subdividing *tala* cycle				*Vibhag*				*Vibhag*				*Vibhag*			
tali	Marks the beginning of *tala* subdivision.			*tali*				*tali*				*tali*			
								Khali closed bols							

Table 5: *Tihais* in prime numbers for *tintal* and 4/4 time, indicating important starting points and cross-referenced for both the Indian and Western musician. In 4/4 time, red numbers indicate beginning or midway cyclic starting points; even blue numbers are also admissible

	***Tihais* in *Tintal* 16 Beat Cycle (bracketed notes indicate easy cyclic starting points)**				***Tihais* in 4/4 Time (bracketed notes indicate easy cyclic starting points)**			
Starting points pulses, *Matras* divisions per beat	2	4	8	16	2	4	8	16
$2^{1.5}+2^{1.5}+2 = 9$ 3+3+3 = 9	(13)	15	16	16.5	1	3	4	4.5
$3^{4}+3^{4}+3 = 17$ $5^{1}+5^{1}+5 = 17$	9	13	15	16	(1)	(1)	(3)	4
$5^{3}+5^{3}+5 = 21$ 7+7+7 = 21	7	12	14.5	15.75	(3)	4	2.5	3.75
$5^{5}+5^{5}+5 = 25$ $7^{2}+7^{2}+7 = 25$	(5)	11	14	15.5	(1)	(3)	2	3.5
$7^{4}+7^{4}+7 = 29$ $9^{1}+9^{1}+9 = 29$	3	10	13.5	15.25	(3)	2	1.5	3.25
$9^{3}+9^{3}+9 = 33$ 11+11+11 = 33	(1)	(9)	(13)	15	(1)	(1)	(1)	3
$11^{2}+11^{2}+11= 37$ $9^{5}+9^{5}+9 =37$	15	8	12.5	14.75	(3)	4	4.5	2.75
$13^{1}+13^{1}+13 = 41$ $11^{4}+11^{4}+11 = 41$	(13)	7	12	14.5	(1)	(3)	4	2.5
$13^{5}+13^{5}+13 = 49$ $15^{2}+15^{2}+15 = 49$	(9)	(5)	11	(14)	(1)	(1)	(3)	2

5.3 Linear Plectrum Exercises Using Konokol and Mukthayams

The current availability of knowledge has allowed harmonic and rhythmic thinking to become a choice that overrides musical cultural practices. The continued migration and the cultural exchange between India and Australia and the Internet have allowed unlimited access to knowledge, which musicians can easily take advantage of. From my performing experience, in both countries this access has broken down musical barriers allowing musicians to communicate with each other in culturally diverse musical discourses. For example, Indian musicians are starting to think harmonically about their traditional music practices and Western musicians are combining harmonic concepts with linear rhythmic concepts. Despite this, the concept of harmony has been historically absent in Indian musical thinking. This absence allowed melody, form and structure to be conceptualised linearly and mathematically. In Western improvised music, harmony not rhythm has been the dominant influence in relation to memorising form and structure. For example, when Meyer (1961, pp. 87–95) discusses gestalt theory, psychological organisation, Western music, memory and expectation, he discusses only memory in relation to melody and harmony. Shape and line are terms he uses that could signify rhythmic shape or line; however, this is not specified. His analysis of Chopin's Prelude Op. 28, No. 2 in relation to expectation and memory is entirely centred on melody and harmony. The point here is little attention is given to rhythm and its relationship to memory in western music scholarship. Composers in post-tonal classical music have often developed their own rhythmic concepts and theories, drawing on disciplines outside the Western musical canon in search of new rhythmic principles. This was probably because the rhythmical complexity they were seeking was absent in their own musical traditions (London, 2002, p. 717). The guitar exercises in Appendix C are not harmonically focused, but can be used as 'sheets of sound' over harmony. Many contemporary improvisers already do this, but not often in combination with Carnatic mathematical patterns. The patterns in Appendix C combine 'sheets of sound' and linear Carnatic rhythms.

The linearity of Indian music has historically allowed certain types of melodic patterns, rhythms and instrumental techniques to develop. The guitar exercises in Appendix C have been adapted from Indian instrumental traditions. They include, directional picking techniques, regrouping, *tihais* and some *toda*[6]-like patterns. The right-hand combinations Indian instrumentalists use are extremely varied compared with Western plectrum techniques. I have tried to incorporate some of these techniques—which I learned in lessons with sitarists and from sitar method books, including Bandyopadhyaya (1988)—into these exercises. The patterns are not traditional and can be used in both Indian and Western improvisational settings. The exercises also explore the guitar along the fretboard rather than across it, and always with the *sam* in mind to ingrain a sense of cyclic form. The exercises start with one string, then combinations of two, three and four strings. All patterns are in 4/4 time as Hindustani, Carnatic and Western music have historically leaned towards divisions of four. The advantage an Indian improviser has with linear melodic patterns is they can be used in any time signature because

[6] A '*toda'* in north Indian music is an instrumental technique featuring combinations of melodic rhythms that fit into a *tala* cycle, executed either with a *mizrab* on sitar or a plectrum on *sarod*.

they are not restricted by harmony. The exercises can be superimposed over harmony but can be problematic when combining long rhythmic phrases with changing or complicated harmony. These exercises, hopefully, will present a starting point for the guitarist to experiment with, for instance, numbers, different speeds, *mukthayams, tihais* and *nadai*.

5.4 Thinking in Cyclic Form

Many Western scale and improvisation method books focus on jazz patterns in relation to harmony not rhythm. A very comprehensive book on jazz improvisation by Hal Crook dedicates only a few pages to rhythm (Crook, 1991, pp. 95–104). Bergonzi's book, *Inside Improvisation* (1994) is primarily focused on rhythm but is mostly limited to semiquavers, quavers and triplets within two- and four-bar phrases. Here, the improviser is left to string these rhythmic ideas together. Ronan Guilfoyle's book, *Creative Rhythmic Concepts for Jazz Improvisation*, is a rhythmical advancement for jazz musicians as it incorporates rhythmic concepts from Bulgaria and South India and explains how to use these concepts in jazz improvisation (Ronan, 1999). There are some excellent texts that incorporate rhythmic systems from other cultures; however, they are generally not mainstream texts for jazz musicians.

The consequence of this lack of rhythmic method for Western musicians can be getting lost in static modal tunes because performers are taught to rely on changing harmony as a guiding structural reference rather than thinking mathematically. A case in point would be the modal tunes 'So What' and 'Milestones' by Miles Davis (1959), 'Little Sunflower' by Freddie Hubbard (1967) and 'Cantaloupe Island' by Herbie Hancock (1964), where novice musicians become lost using only two chords in a 32-bar form. As an undergraduate jazz musician, I was taught to begin somewhere within a two or four-bar phrase. What I was not taught was where to stop. I found knowing where to stop essential for knowing where I was in a static modal tune. Knowing where to start and where to stop are equally important in Carnatic music: a concept that greatly helped me with the geography of form. Once this method of playing within rhythmic cycles is mathematically mastered, form and improvisation can be memorised and analysed independently, either through rhythm, melody or harmony. Moreover, the patterns in Appendix C were a starting point for me to explore a variety of linear rhythmic concepts that helped me calculate rhythms in *tala* and cyclic form in different improvisational contexts (see Appendix C).

Chapter 6: Introduction to Analysis

6.1 The Influence of the Cultural Discourses of Western Harmony and Indian Rhythm on my Compositions

My question regarding Western harmony and Carnatic rhythms is: How can a convincing grammatical, melodic and harmonic structure combined with a linear rhythmic structure be created? Moreover, I have examined my original compositions regarding the benefits and difficulties in combining Western and Carnatic rhythms and the influence of Indian cultural discourse on my thinking. These original compositions draw on three different musical discourses: Western classical, Carnatic and Hindustani. There are many pitch similarities between Western scales and ragas. However, the application of raga and the Western scale system is completely different. The difference being Western music has predominately functioned harmonically and Indian music linearly. The marriage between vertical harmony and linear rhythm is the prime focus of my compositions. The rhythms and ragas used in the following compositions except for *bhimpalasi*, are from Carnatic music (see Appendix D). I have used a combination of both Indian and European musical terminology, theory, aesthetics and music performance practice. I have found using both Western and Indian analytical approaches extremely valuable in understanding Indian music, sociologically and philosophically, and in connecting these two musical traditions.

All music is connected to other institutions, discourses and cultural practices, including religion, mathematics, ceremony and philosophy. This cultural reciprocity in Indian music has consequently informed my own compositional practice in that I see music and the world as evolving patterns that can be understood mathematically. This strong connection and reciprocity in Indian music has consequently informed my own compositional practice. It is questionable that music has an *intrinsic* nature or meaning, but for the purposes of this analysis I will consider cultural practices and music as an intertwined creative process, not a belief system. Analysis of another culture's music always carries with it assumptions when viewed through the Western colonial gaze. Despite these misgivings, understanding Indian culture, philosophy and aesthetics is difficult to separate from the music itself. Like other musical cultures, social and institutional discourses are not always mutually exclusive from musical discourses. The cultural discourses associated with Indian music are important in explaining the compositions presented here. The Indian musical aesthetic has especially informed my compositional choices and musical understanding, regardless of my own personal and philosophical beliefs. Whether musical meaning is absolute form and structure or is associated with cultural discourse is an endless debate and heavily influenced by context. The meaning of music is fluid and consubstantial with other discursive institutional practices. Leonard B. Meyer touches on this subject when he states that meaning exists on a continuum between referentialism and absolutism (Meyer, 1961, pp. 1–10). This theory puts an end to any future search for musical meaning: it is left hanging on the absolute and social continuum. Michel Foucault similarly explores the limit on meaning in his concept of 'Discursive Regularities and Formations', albeit more convincingly because his exploration reaches further than just the referential and social and explores power, institutions and biology (Foucault, 1972, pp. 21–71). This divide between ideological positions on musical meaning is made very explicit in an interview between Michel Foucault and Pierre Boulez in 'Contemporary Music and its Public' (Foucault, 1988, pp. 315–330). It shows Boulez as being unwilling to see music as consubstantial with other cultural discourse. The point here is that Western music analysis leans towards absolutism and formal content, as can be shown by Boulez's attitude. I find it counterintuitive as a Westerner to view Indian music only from absolutism. In Western music analysis, this is a common and fanciful trope where aesthetic musical autarchy negates reference to other phenomena, music or cultural meanings. That one could invent or analyse a musical language without reference to other musics or culture, or without recourse to syncretism and based purely on conceptual invention is fantasy (Born & Hesmondhalgh, 2000, p. 16). It is with this caveat that I examine Indian culture and music from both a Western and an Indian point of view.

Etude No. 1 was my first attempt at adapting both *mrdangam* patterns and *konokol* phrases to the right-hand fingering patterns of the classical guitar. I considered the relative pitches of the *mrdangam* and adapted these to the real pitches and strings of the guitar and to the improvisations and compositions presented here. There are many difficulties in combining Western tonal harmony and linear Indian rhythmic concepts. The problem lies between the relationship of vertical tonal harmony and extended linear rhythm. The two do not always combine easily and usually involve some sort of compromise. For example, when long linear rhythmic phrases like *korvais* are constructed using conventional Western melody, harmonic rhythm and bar structures, they can lose their impact, making linear rhythmic structure very difficult to achieve. This is because *korvais* are linear and when combined with harmonic rhythm and bar structures, linear rhythms become compromised to vertical harmonic concepts. In Etude No. 1, the linear rhythm is disrupted by harmonically driven pitch sequences, making it less and less convincing and perceptible as a linear rhythm. In short, long linear rhythms like *korvais* will not always keep their integrity when adapted to changing harmony. However, one solution is combining tonal harmony and *korvais* in parallel. This means that the time signature and harmony should change to suit the phrase of the *korvai* (see Figure 72).

In Etude No.1, after the exposition I felt I had compromised when cross-pollinating these musically disparate concepts. The introductory rhythmic cell and harmonic movement did not allow linear rhythmic complexity without changing the nature of the composition. That compromise changed my usage, complexity and adaption of long linear *korvais* and rhythms. This does not mean that Etude No.1 was a failure but it did alert me to what compositionally worked and what did not. After this realisation, I took several different approaches in the following compositions that allowed me to compose using *korvais* and harmony simultaneously.

Generally, I found that the more complex the tonal harmony, the less rhythmically complex my compositions became, and the more rhythmically complex, the less I could use complex tonal harmony. The exception was free atonality, where both linear rhythm and harmony could coexist in a less hindered way. Free atonal harmony worked best when subservient to linear rhythms; the merging of these two ideas presented fewer compositional problems for me. The outcome of this experimentation prompted the question: How does one create both a convincing atonal, grammatical, melodic and harmonic structure combined with linear rhythmic structure? Etude No. 1 was the beginning of an intuitive discovery of how these two musical systems could be combined. Although I did not incorporate many of these ideas into Etude No. 1, it was a discovery of the complexities and problems of fusing two culturally disparate musics.

Chapter 7: Analysis: Etude No. 1 for Solo Classical Guitar

In Etude No. 1, I wanted to explore two things: to treat each string as a drum sound and to use different rhythmic groupings while remaining in time signature of 4/4. I experimented with many semiquaver combinations, for example, 6, 6, 4 and 2, 3, 2, 3, 2, 4. For the right-hand fingering patterns and semiquaver groupings I chose (3, 3, 3, 3, 4): this was musically and physically natural to perform, bringing out particular rhythmic patterns and melodic structures from the chord voicings. For example, a *tisra nadai* pattern feels especially good when played with *p, i* and *m* fingers across three groups of adjacent strings because the weight of the thumb naturally accents the first note of each *tisra nadai* pattern. What makes some of the arpeggio patterns interesting is when the thumb is used on the higher notes of a particular voicing. These arpeggios bring out some unusual harmonic accents within the chord because the thumb is no longer playing the bass or root note.

Traditionally, the thumb is used for bass notes in guitar music: when used on higher notes within a chord voicing it is no longer a bass note but an inner voice or accented melodic part within the phrase. In Figure 1, the thumb plays the F# on the third string, which is higher than the remaining E and B treble strings. The thumb is now starting to function as an independent melodic unit that can weave between string registers and bring out an independent melodic and rhythmic structure. It is a simple and effective compositional technique that is particular to guitar composers. Its usefulness lies in the fact that the physical weight of the thumb can bring out a subtle linear melodic line within an arpeggiated chord.

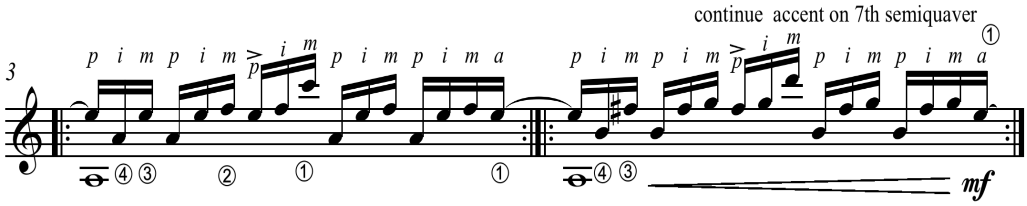


Figure 1: (*Ta ki ta*) x 3 + (*ta ka di mi*) translates as (3 x 4) + 4. This technique uses *p, i,* and *m* across adjacent strings to achieve similar articulations that mimic *mrdangam* patterns

This right-hand pattern is used throughout Etude No.1 (Figure 1). The melodic structures come from the chord voicings and not from variations in the right hand. For example, Figure 2 demonstrates parallel harmony using identical chord shapes: in the thumb, we have a real sequence in ascending fifth intervals with each new chord. Keeping the right-hand pattern, this same technique can be utilised further by moving some of the left-hand fingers along the strings or lifting some of the fingers off completely, allowing an open string to ring, hence changing both the voicing and melodic outline of the chord. In Figure 3, the moving chromatic line is played by the thumb (*p*) on the fourth string. In Figure 4, bar 16, the moving voice is played by the middle finger on the B string, still with the same right-hand fingering pattern. These techniques are effective because they make a static chord take on a new melodic structure and add some counterpoint.

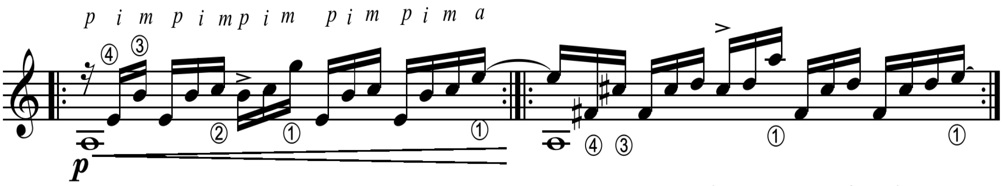


Figure 2: Melodic variations coming from left-hand movements. The third finger is lifted to get an open string while moving the harmony in parallel. The right-hand fingering pattern is assigned to specific strings, just like the finger strokes of the mrdangam player are assigned to a particular area of the drum

Figure 3: The left-hand fingers move along the treble E and bass D strings to produce different pitches, adding two counterpoint lines while maintaining the original right-hand pattern

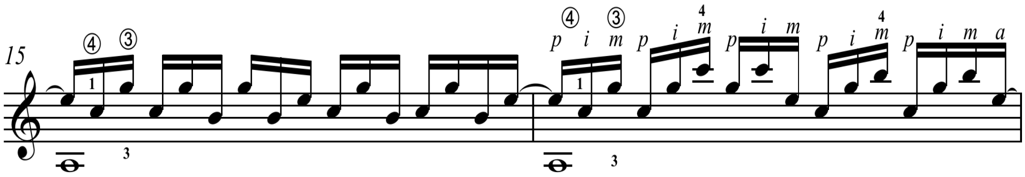


Figure 4: Counterpoint lines added by left-hand movements on the B string only

At bar 44 (Figure 5) the right-hand fingering changes to *p, m, i* on two strings with a linear melody rather than an arpeggiated chord sequence. Carnatic drummers have an amazing ability to use one idea in a myriad of permutations and make each sound different. I have implemented a similar idea here by using *p, i* and *m* as a *tisra nadai* pattern for both linear melodies and arpeggio patterns with various string combinations.

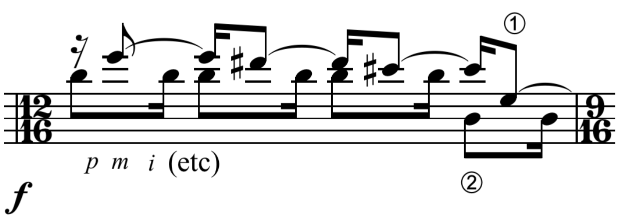


Figure 5: Utilising the original *p, i, m* arpeggio pattern to create a linear melody on two instead of three strings and using both open and fretted strings to add new melodic variations

In Figure 6, the intervals in the chord are close together and could be played traditionally with fingers *i* and *m* like a regular scale. The effectiveness of the chord voicing allows this scale-like passage to be arpeggiated very quickly using the same right-hand pattern and sound like a linear melody rather than an arpeggiated chord.

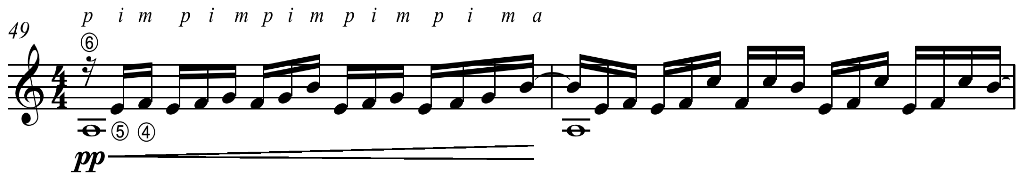


Figure 6: Creating scale-like linear melodies by using open strings and *tisra nadai p, i* and *m* finger combinations

Etude No.1 continues with the opening arpeggio pattern and resolves with three *mukthayams*. The first is a 5 x 3 *mukthayam* Figure 7 bar 81. On the *mrdangam*, each group of five has identical sounds—that is, *Ta di gi na tom* x 3 *Tam*. The guitar phrase almost follows this rule except for the beginning G#. The last G#, bar 82, is the lowest note in the phrase, and *tam* is also the lowest and last note of a *mukthayam* phrase. In performance practice, this is not always the case. However, cadences and finality are musical constructs often weighted towards ending on a low, loud pitch and are worth considering when constructing *mukthayams.* It is perhaps what traditional Indian and Western music have in common when it comes to cadential formulas.

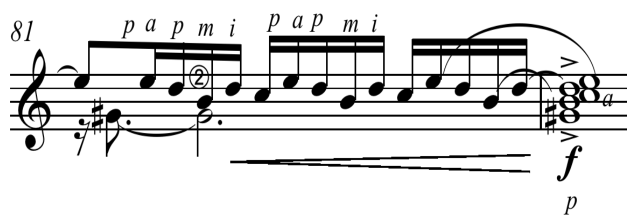


Figure 7: An example of a *mukthayam* that follows the relative pitch contour of the *mrdangam*

Figure 8 is a simple *mukthayam* of 16 x 3, each phrase being exactly the same. This is a set-up for a more complex *mukthayam* of (9 + 2 *karvai*) x 3 in Figure 9. Both *mukthayams* use the same Gadd4 harmony and function as rhythmic and harmonic cadences in preparation for the recapitulation beginning at bar 89. In Carnatic music, usually the most complex rhythmic sequences are saved just before the main theme returns; I chose the same compositional idea, shown in Figure 9.

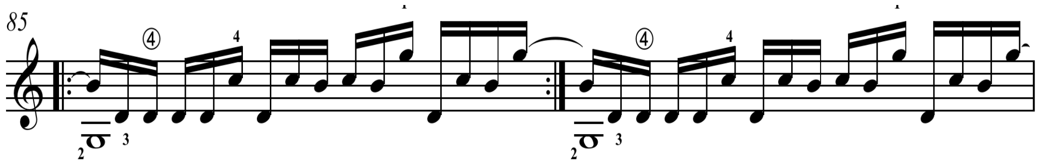


Figure 8: A simple *mukthayam* of (16 x 3) that develops into a more complex *mukthayam* just before the recapitulation

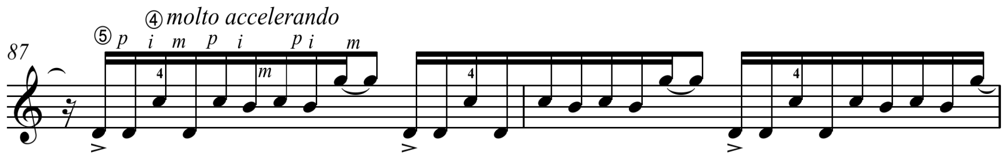


Figure 9: A complex *mukthayam* leading into the recapitulation (9 + 2 *karvai*) x 3 taken from the standard phrase of (11 x 3)

Chapter 8: Analysis: *The Wait* for Solo Classical Guitar

The purpose of *The Wait* for solo guitar is to combine classical guitar techniques with jazz improvisation and Carnatic rhythmic improvisation in the one composition. I have included some essential information that the performer will need to become familiar with to complete this task. This information will save the classical guitarist a considerable amount of time and allow them to explore their own way of improvising in this composition and in improvisation in general. It is evident especially with the guitar that many practice techniques specific to genres have evolved. However, when cross-pollinating new musical styles, technical deficiencies become apparent. *The Wait* is possibly problematic in this sense to both the classical and jazz guitarist because the classical guitarist is not familiar with improvising and the jazz guitarist will need some finger style technique to play this composition. An added problem is that the techniques presented here are designed for solo guitar improvisation on the classical guitar. The nature of specialist institutional musical discourses and the lack of social interdisciplinary modes of expression make it difficult to generate new forms of improvisation. I hope this piece presents a boundary that the classical and jazz guitarist is prepared to cross.

The improvised section of *The Wait* uses two simultaneous modes over each chord to create some harmonic ambiguity. The aim is to direct the improvisation into unexplored harmonic and rhythmic territories (see Table 6). The harmony here is different from that used in the composed section of *The Wait*. The modes used are the fifth mode of the melodic minor (Mixolydian *b*6). In Carnatic music, it is called *Charukesi* and is the 26th *melakarta* raga in the 72-*Melakarta* raga system (Narasimhan, 1999, p. 91). *Charukesi* translates as 'with beautiful hair' and its mood historically has been expressions of longings, yearnings, love, pleading, pathos and devotion. It is not mentioned in the *Raga Guide* by Joep Bor but is often played by North Indian musicians. Table 6 and Table 7 outline the modes and ragas in three different systems. The Lydian augmented scale is also used but is not a *melakarta raga* because the *pa* note is absent and two *dha* notes are present. There are, however, strong similarities with some *janya* ragas, like the *Mechakalyani* raga 65 that avoids *pa.*

8.1 Scales and Modes used in *The Wait* for Solo Guitar

Table 6: Modes used for improvisation in *The Wait* for solo guitar

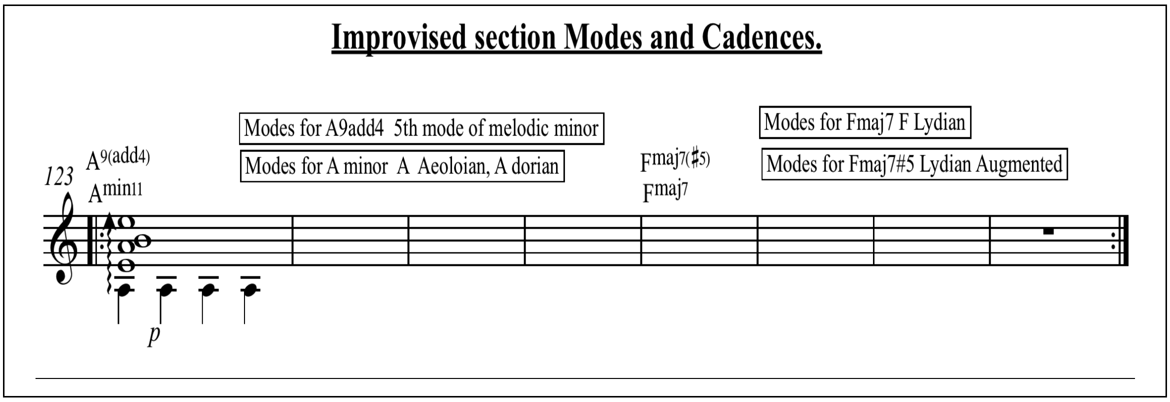


Table 7: Scale chart/modes in Western, Hindustani and the *melakarta* system

Western Scale Name	Hindustani Raga	72 *Melakarta* System
Dorian	*Kafi*	*Kharaharapriya* 22
Aeolian	(*Asvari*) same notes *Darbari Kanada*	*Nathabhairavi* 20
F Lydian augmented	Not a Hindustani raga or a *Melakarta* raga	
F Lydian	*Yaman*	*Mechakalyani* 65
Mixolydian *b*6, 5th mode of melodic min ascending	*Charukesi*	*Charukesi* 26

I have outlined a list of chord voicings that utilise open strings. This allows free left-hand fingers to play notes from the ragas not used in the chord. The voicings cover the entire range of the guitar: knowledge of all these voicings allows melodies, comping patterns and bass lines to be created with relative ease around the voicings at hand. If the solo guitarist is to do this well, it is essential that all the appropriate modes and harmonic possibilities should be based around each chord voicing. For the jazz guitarist, this practice is common; however, some of the right-hand classical techniques might present some technical problems. The use of open strings in the chord voicings will also help the performer easily move to and construct linear improvisations when moving between new chord shapes and scale patterns.

All the chord voicings and modes are interchangeable; the idea behind this was to explore a more ambiguous pathway into freer harmonic territory. I felt this ambiguity a compositional necessity to balance the composed section of *The Wait,* which is harmonically conventional and modally static (see Appendix D, p. 237, *The Wait* for solo classical guitar).

8.2 The Application of Mukthayams to the Guitar

The *mukthayams* used in *The Wait* are familiar to the South Indian percussionist and are based on the *ta di gi na tom* family of rhythms. I have applied my own harmonies and pitches to these *mukthayams*, which are quite different to the original pitch contour played by an Indian percussionist. While I have outlined a substantial number of patterns for the *ta di gi na tom* family of rhythms (see Appendix A), I would encourage the improviser to create their own harmonic patterns and rhythms based on *mukthayams*. It is important that *mukthayams* are learned firstly as a cadential formula: it is only then that they can be used effectively and freely in improvisation. Of course, the improviser is free to do what they like, but the rigidity of this concept and approach paradoxically creates rhythmic freedom for the improviser. Therefore, I would always start by resolving *mukthayams* on the *sam*. The Carnatic system, like other advanced musical systems, imposes structures that create musical freedom and provides a structural reference point for development. The use of *mukthayams* and *nadai* patterns combined with harmony are excellent improvisational techniques to explore this freedom. The performance notes and examples presented in Appendix D in the 'The Wait for solo guitar' demonstrates in the context of this composition, a variety of approaches on how to resolve *mukthayams* using varied harmony when improvising.

Figure 10 is a *mukthayam* of 8 x 3 that uses the same harmony within a two-bar structure. This is probably the simplest approach because you can keep each melodic repetition of the phrase the same as there is no harmonic change within the bar. In the improvisation section, both A minor and F major seventh are four bars long; this means that any *mukthayam* that fits within a four-bar phrase can remain melodically and harmonically identical.

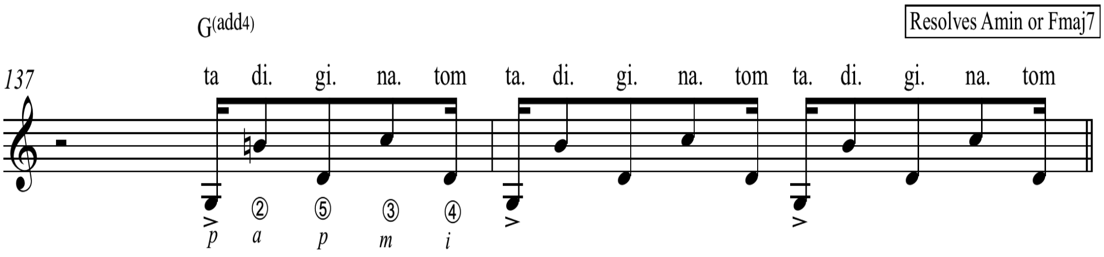


Figure 10: A *mukthayam* of (8 x 3) using identical harmony resolving to chord IV

Figure 11 keeps the rhythmic integrity of the *mukthayam* and gives each new grouping a different harmony. This technique is very effective when superimposing, exploring or replacing existing harmony, in this case replacing F major seventh.

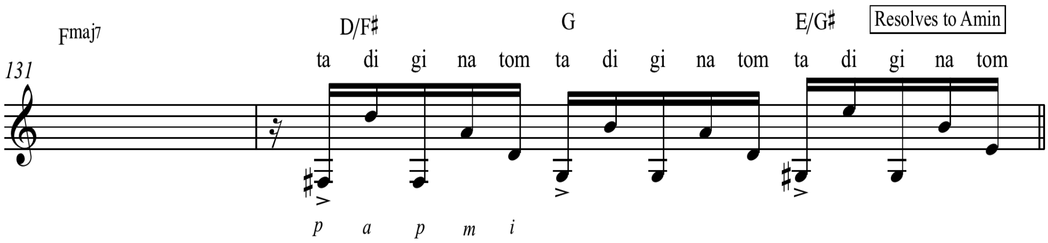


Figure 11: A *mukthayam* of (5 x 3) using different harmony in each repetition resolving with a perfect cadence

Ta. di. gi. na. tom (9 x 3) (Figure 12) is a diminished pattern and is a difficult rhythm to play, but filling in the semiquaver gaps with a treble part makes it easier and creates an independent line while maintaining the integrity of the original *mukthayam* in the bass. The beginning note, A, is not part of the *mukthayam* but helps rhythmically set up the *mukthayam*. Figure 13 is also a diminished pattern in double time using a *mukthayam* of (10 x 3).

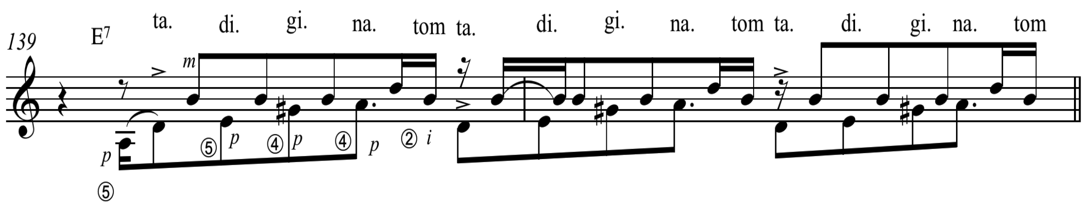


Figure 12: A *mukthayam* of (9 x 3) in the bass with a counter melody in the treble using a diminished pattern

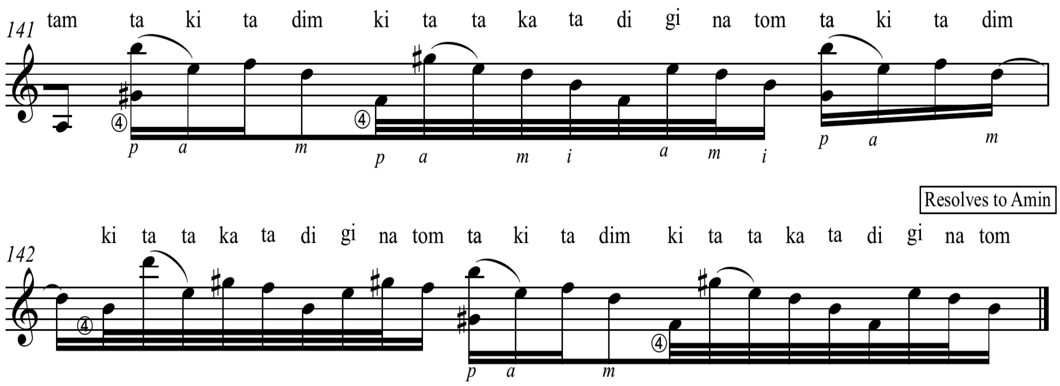


Figure 13: A *mukthayam* of (10 x 3)—a diminished pattern that moves up and down the neck in double time utilising slurs and open strings

These *mukthayams* for *The Wait* (see Appendix D) are based on arpeggiated chords. You could also use the same idea using linear scale patterns. John McLaughlin is an excellent exponent of linear scalic improvisation. Arpeggiated chords and *mukthayams,* however, are especially suited to solo and accompaniment guitar patterns, so it is important to resolve to a bass or a harmony note on *sam.* This is particularly important for solo guitar playing because it adds a clear sense of resolution.

8.3 Nadai and Metric Modulation

Nadai is a Tamil term referring to the rate at which inner pulse divisions move within a *tala* beat. Traditionally, this concept is used to maintain the same pulse and move into a different speed using the same pitch sequence. *Nadai* is a simple and excellent way of developing new material from a single idea. Once the new speed is chosen, the new phrase is calculated so the last note of the phrase is the penultimate note before the *sam* or it lands on the *sam*. The *sam* allows a point of release after which a new *nadai* / improvised phrase or *mukthayam* can begin again. Lisa Young (2010, p. 24) suggests this is known as time shifting or *laya rathna* and she explains this concept as a metric modulation. However, this is a slightly inadequate explanation because a performer has to feel a metric modulation very differently to the same phrase played in different *nadai*. The feeling in the body of *nadai* is completely different and ultimately more rhythmically complicated and satisfying. The determining factor here is that the longer a new phrase persists, the more likely it will be perceived as a metric modulation. Both ideas are present in Indian music, although playing the same phrase in different *nadai* is more common. Nelson (1991 p. 90) explains the development of *nadai* in three categories. The first is a *savalaghu* pattern where various groupings play against each other in the context of a composition. Another *nadai* application is to use a *korvai* in which the *nadai* changes in the three repeated sections. The last is to change the *nadai* suddenly. In all these applications, the pulse remains the same and does not involve a metric modulation.

8.4 Recording *The Wait*—Bass Lines using Nadai and Mukthayams

The recording of *The Wait* for solo guitar presented some interesting problems. For example, when a bass or root of a chord is used as part of a *mukthayam* it can disrupt the phrasing and final resolution. This is especially evident when the bass note does not begin each of the three phrases. The placement of the bass note or tonic is crucial within the phrase and needs to be placed on the beginning of each phrase or just on the *sam* to give the listener a sense of resolution. Of all the notes in a chord, the tonic is probably the best choice as a final cadence; if the intent is to stretch the listeners' perception of where the *sam* is, then having a bass note randomly as part of a *mukthayam* can create deliberate rhythmic unrest. If a *mukthayam* is based on the upper extensions of a chord and a solo bass note is placed just before the *sam,* it could quite easily be perceived as the *sam*, even if the listener is attentive to the rhythmic calculation. In making these assumptions about cadences, I am keeping in mind what is musically accepted as a cadence both from an Indian and Western perspective. However, a fusion of cadential forms will develop and depend on evolving musical traditions and constructs.

What I found most acceptable as a harmonic resolution on the *sam* of a *mukthayam* was either a bass note or the upper extensions of a chord and a bass note played simultaneously. Cadential resolutions are socially constructed in both Western and Indian music and must be taken into consideration when blending two disparate musics. I have tried to blend and manipulate both musical constructs and use them as compositional tools. However, such a creative process involves *effectively* communicating disparate musical concepts to both Western and Indian audiences.

Counting time through *mukthayams* and *nadai* patterns is interesting and challenging to both listener and performer. When listening to my own solos, I found I often perceived the *sam* in the wrong place; this was especially revealing when using *nadai* patterns. In my improvised solos, I used *nadai* patterns intuitively but practised them in highly calculated ways, making sure I always resolved them on the *sam*. The transition from practised calculations to intuitive improvisation is not an easy task. This led to an important performance practice: these rhythms must be practised accurately against a strict pulse with no rubato; it is only then they can be used spontaneously within a time cycle. The main *nadai* concept I was incorporating into my improvisations could be summarised as follows: different *nadai* patterns can be multiplied by the number of divisions they take up within the *tala* cycle. For example, a 16-semiquaver pattern in 4/4 time changed into triplets will take up a third of four bars; multiplied by three, it will take up four bars evenly (Figure 14). Likewise, the same phrase in quintuplets takes up a fifth of four bars; multiplied by five, it will fill up four bars evenly (Figure 15).

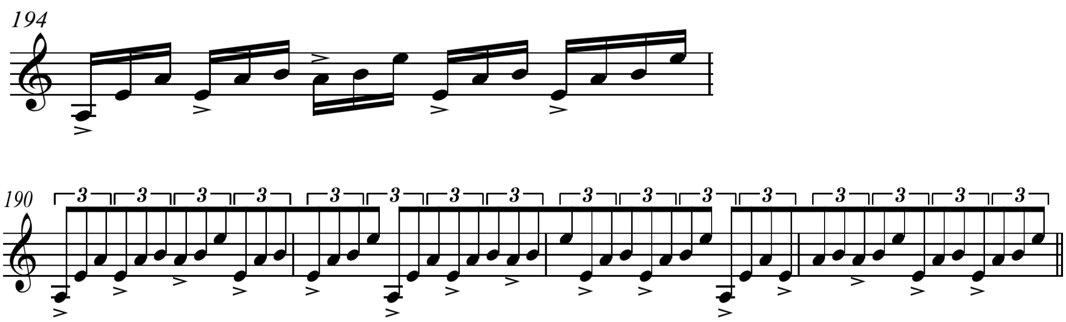


Figure 14: A *nadai* pattern of 16 semiquavers transformed into triplets multiplied by three takes up four bars evenly

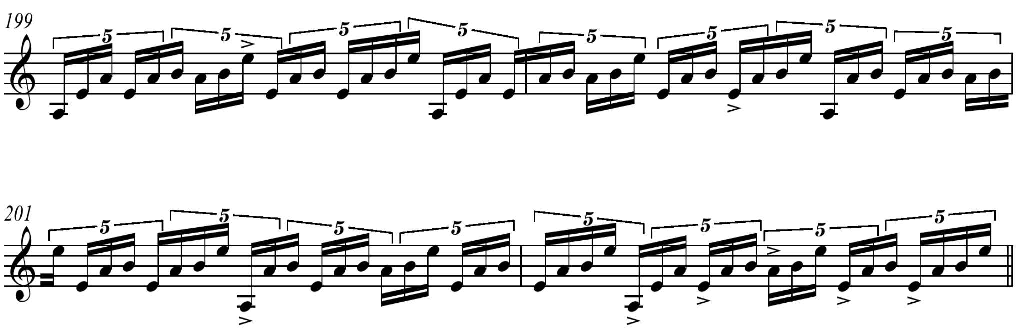


Figure 15: A *nadai* pattern of 16 semiquavers transformed into quintuplets multiplied by five takes up four bars evenly

This idea can be used with any subdivision almost like a card trick, although higher subdivisions after 10 at fast tempos are aurally difficult to perceive and often become a flurry of notes rather than an aurally perceptible and calculated rhythm. *Nadai* patterns are creatively endless and very useful in creating improvisatory patterns with limited material. Whatever the *nadai* pattern, it is always helpful to know the starting and ending points within the *tala* cycle or bar structure. Figure 16 demonstrates the same phrase played in different *nadai* taking into consideration the starting and ending points of each phrase.

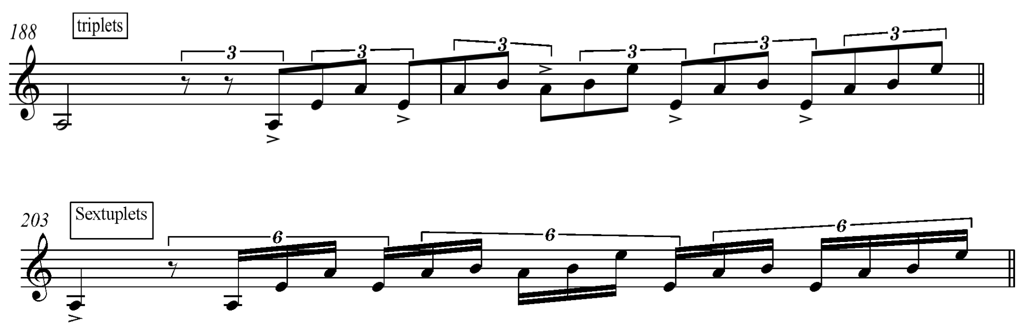


Figure 16: Original semiquaver patterns (Figure 14) transformed into different *nadai* patterns taking into consideration the ending and starting points so each phrase lands on the *sam*

8.5 *The Wait* for Flute and Guitar: Melodic and Rhythmic Concepts

The following analysis applies to both the solo guitar and flute and guitar versions of *The Wait.* The analysis concentrates on outlining Indian rhythmic concepts in conjunction with Western harmony. The composed section of *The Wait* is based on raga number 20 *Natabhairavi* in the *melakarta* system and is called raga *asvari* in Hindustani music. There is great dispute about this because some interpretations of *asvari* have a flat *ni* and flat *re* (Bor, 2002, p. 24). In Western music, the raga is called the Aeolian mode (see Table 7).

The first *mukthayam* (*ta di gi na tom x 3*) is used in the guitar part (Figure 17). The second note in each group of five moves in a descending pattern to create some melodic movement within the three phrases. Bar 12 outlines an E dominant chord resolving to A minor at bar 13. Here, both Western and South Indian cadential systems are juxtaposed.

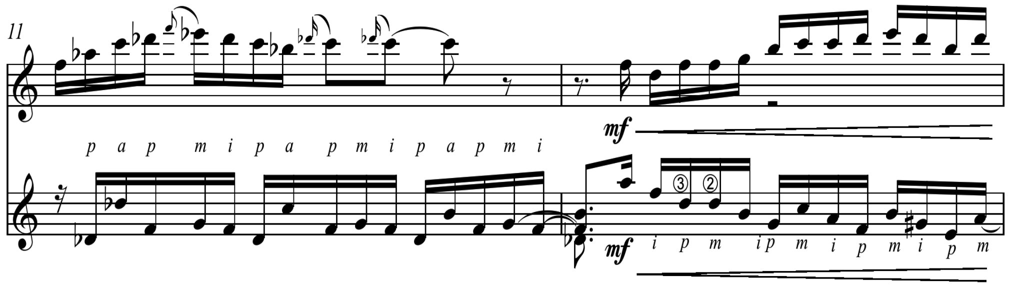


Figure 17: Two cadences used consecutively, one Indian, the other Western. The first a 3 x 5 *mukthayam* followed by a perfect cadence in A minor

A North Indian *tihai* is slightly different from a *mukthayam*, but it is still a pattern repeated three times. However, if a *mukthayam* is moved forward one *aksara* it becomes a *tihai* because the last note of the last phrase now lands on the *sam* (Figure 18, bars 27–29). In addition, there is a slight pitch variation in the last phrase at bar 28—also a common practice in Indian music.

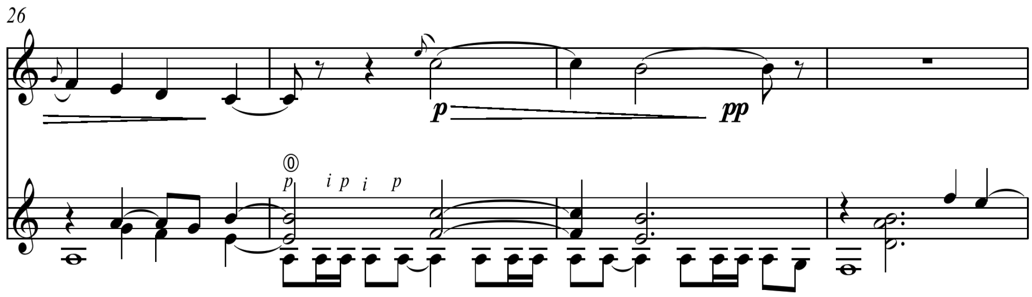


Figure 18: Simple *tihai* used in the bass notes of the guitar 3 x 3 crotchets bar 27

Bars 33–34 (Figure 19) are also a *tihai.* The first two phrases are identical; however, the last phrase in bar 34 has the same sequence of notes but in a different *nadai*, that is, semiquaver triplets instead of the original semiquavers. The flute at bar 34 begins a *mukthayam* of (6 x 3), which begins by dovetailing into the ending of the guitar *tihai* at bar 35. The flute continues in parallel sixths and rhythmic unison with the guitar setting up a transition into a new section beginning at bar 36.

8.6 Linear Displacement and Nadai

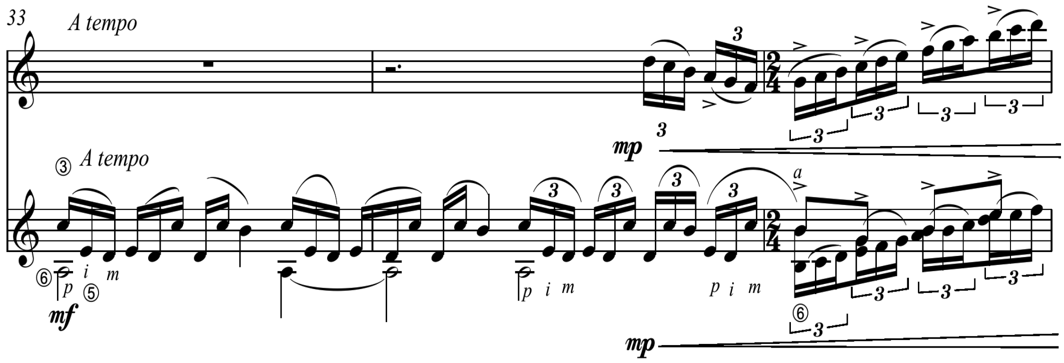


Figure 19: A *tihai* of 10 x 3 bar 33 with the last phrase transformed into triplets, dovetailing into a new *mukthayam* of 6 x 3 in the flute part bars 34-35.

In bar 38 (Figure 20), both the flute and guitar play the same one-bar phrase in every alternate bar but displace it by one semiquaver. This phrase shifting is an integral part of *tihais* and *mukthayams*; in both cadential forms, the second phrase is often played on the offbeat and sometimes across the bar line or *vibhag.* Figures 18 and19 are examples of this. In Figure 21, the same displacement idea is repeated but the phrase is now in triplets (bar 44), with the remaining notes of the original phrase left out, which allows the time signature to remain the same.

Figure 20: Phrase displacement by one semiquaver

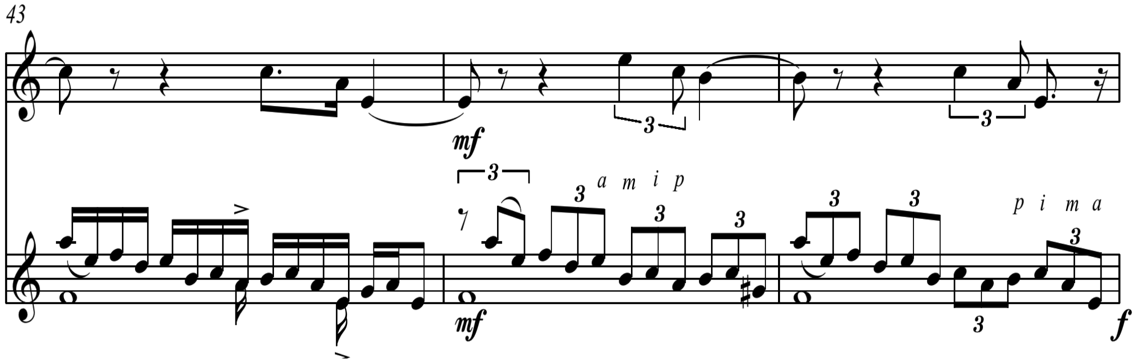


Figure 21: Bar 38 transformed into *tisra nadai* with notes left out, allowing the phrase to resolve on *the* sam without changing the time signature

Bars 47–54 move away from phase shifting and the phrase starts to develop freely around E dominant seventh harmony over pedals A and F, eventually resolving to A minor in bar 55. This transition section is a set-up for two extended *gopucca yatis* (Figure 22) in bars 55–67, ending with a *mukthayam* of 7 x 3 (Figure 23) in bar 68.

Figure 22: Two extended *gopucca yatis* ending with a (7x3) *mukthayam* bar 68 in Western notation

The *gopucca yati* used in Figure 22 (bars 55–60) is as follows: (7x4) + (6x4) + (5x4). This is followed by a transition *mukthayam* in 15/16 time and then another more extended *gopucca yati* (7x4) + (6x4) + (5x4) + (4x4) + (3x4) + (2x4) + (1x4) + a (7x3) *mukthayam* (Figure 22, bars 61–67). I have written the *gopucca yati* using both mathematics and Indian notation, which visually demonstrate its geometric structure.

ta di . gi . na . tom x 4
ta di . gi na tom x 4
ta di gi na tom x 4

ta di gi na tom x3 transition mukthayam 15/16 (bar 60)

ta ka di mi ta ki ta x 4
ta ki ta ta ki ta x 4
ta di gi na tom x 4
di gi na tom x 4
gi na tom x 4
a tom x 4
tom x 4.
(7x3) mukthayam (ta di…..)+ (ta di …..) + (ta di …..)
sam

(7x4)+(6x4)+(5x4)+(3x4)+(2x4)+(1x4)+(1sam)
(7x4)+(6x4)+(5x4)+(4x4)+(3x4)+(5x4)+(2x4)+(3x4)+(2x4)+(1x4) ending in a *mukthayam* (7x3) with *karvai*

Figure 23: Two *gopucca yatis* followed by a 7 x 3 *mukthayam* in both *konokol* and mathematics.

The guitar does not vary the rhythms and stays in one *nadai* (Figure 22). The flute, however, extemporises around the guitar rhythms using different *nadai* patterns and both the guitar and flute are beamed similarly, adhering to the mathematical structure of the *gopucca yati.* This helps visually identify the diminutive groupings. In this instance, using conventional Western notation beamed according to harmonic rhythm disguises linear rhythm but makes the pulse clearer.

The *mukthayam* in Figure 24 is interesting in that large parts of it are silent in the guitar part. This type of *mukthayam* in Carnatic music is accepted as 7 x 3, even though the last five semiquavers are silent. The silence in all three phrases allows the structural integrity of the *mukthayam* to remain as 7 x 3 even though *the sam* is the second semiquaver of the last phrase. The Western musician would perhaps identify the rhythm (7x2) + 2. It is a learnt musical expectation that is perhaps cultural rather than aural.

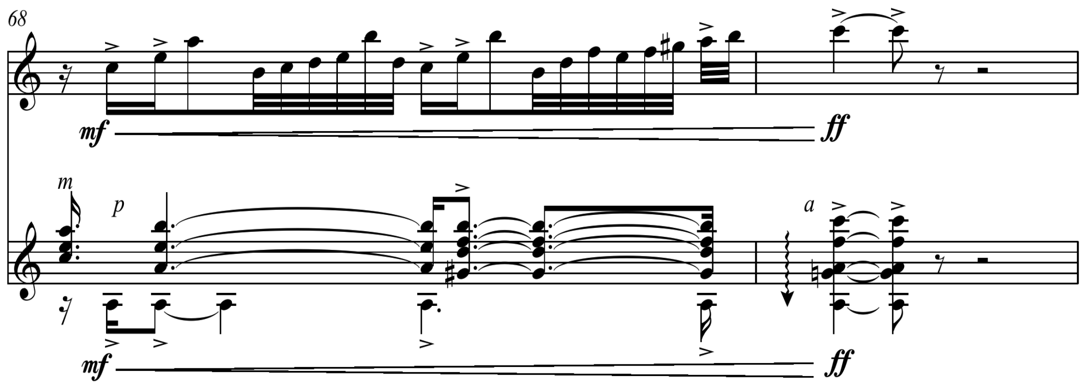


Figure 24: *Mukthayam* of 7 x 3 with *karvai*, the *sam* being the second last semiquaver of the last phrase

Bars 70–95 have an *alap* feel but use more of a Western compositional approach using pedal points and free extended techniques in the flute. This variation uses the same harmonic progressions used in the improvised section of *The Wait* for solo guitar.

In bar 96 (Figure 25), the guitar begins a series of descending chordal clusters from the *Nathabhairavi* scale over an A pedal point. I have arranged each chord to sound like a linear melody rather than a chordal cluster when arpeggiated. The guitar plays a *nadai* pattern in quintuplets using the same right-hand fingering pattern throughout. Again, the right hand treats each string like a drum sound, that is, *ta di gi na tom.* The quintuplets give the composition the illusion of a faster tempo and the opportunity for the flute to play double-time *mukthayams* in quintuplets *ta. di.* <u>*ta di gi na tom*</u> (9 x 3) (Figure 25). The same rhythmic idea is again repeated in Figure 26 using strict *bhimpalasi*.

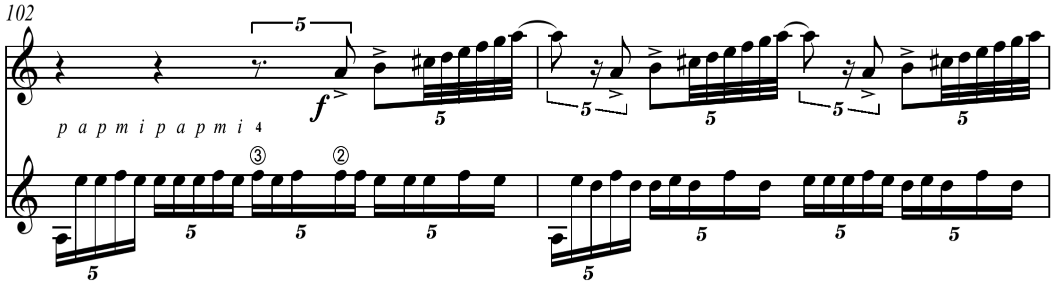


Figure 25: Mukthayam in quintuplets *ta. di.* <u>*ta di gi na tom*</u> 9 x 3

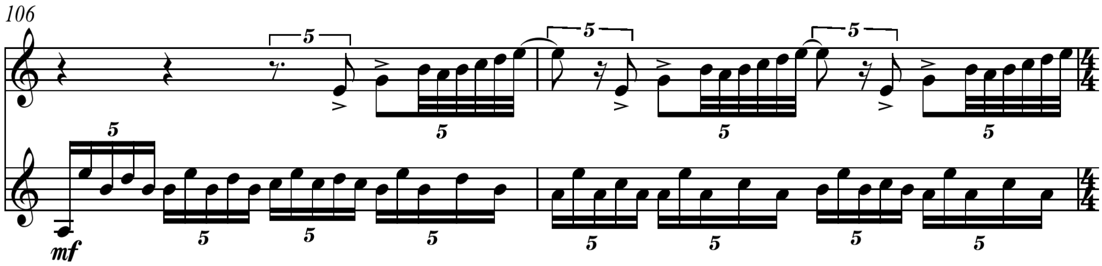


Figure 26: *Mukthayam* in quintuplets *ta. di.* <u>*ta di gi na tom*</u> 9 x 3 using strict *bhimpalasi* in the flute

Bars 108–110 (Figure 27) set up a false expectation of a *mukthayam* or *tihai.* For example, each phrase is repeated three times with the last quintuplet phrase not repeated in its entirety. So, theoretically, it is not a *tihai* but aurally there is enough rhythmic repetition to set up this expectation. I originally conceived this cadence as a *chakradhar tihai* because each beamed phrase can also be divided by three. The G# diminished arpeggio on the third string and the repeated drones on the open E and B strings also make this *mukthayam* function as a V-1 cadence, resolving to A minor in bar 110. Thus, there are two playful cadential cultural expectations going on here: one Western harmonic, the other Indian rhythmic.

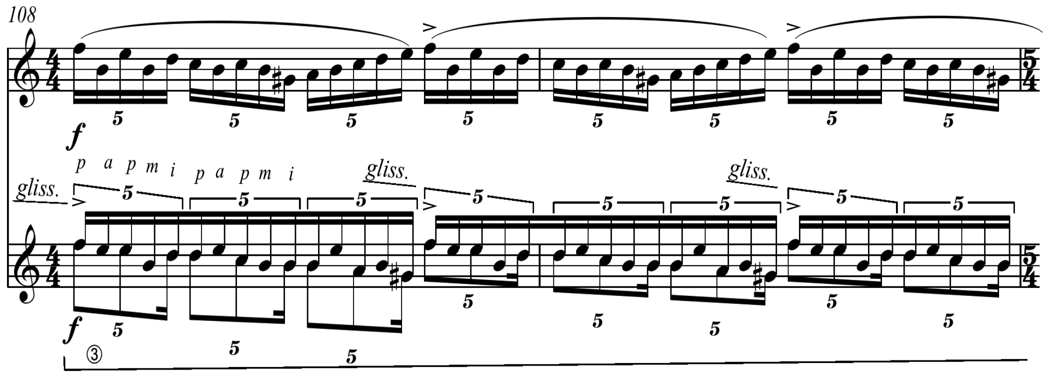


Figure 27: Modified *chakradhar tihai* 15 x 3 with the last quintuplet phrase incomplete

Figure 28 (bars 110–113) shows a transition passage leading into the recapitulation; this is achieved by using a *khanda nadai* pattern, which slows down the harmonic rhythm. This leads into a *chatusra nadai* pattern, which increases the harmonic tempo at bar 112, resolving the composition back to the expositions, harmonic rhythm and tempo. It is an idea taken from *gopucca yati*. At bar 112, it feels like the tempo is getting faster because the space between the bass notes is smaller. However, it is the harmonic rhythm that propels the music forward to the recapitulation, not the tempo.

Figure 28: The same *nadai* used with a *gopucca yati* idea, changing from *khanda* to *chatusra* in combination with harmonic rhythm, giving the illusion that the tempo is increasing

At bar 114, the recapitulation begins. This section uses more Western modal harmony and modulation than Indian rhythmic concepts. Figure 29 is a repetition of the *mukthayam* 5 x 3 used in the exposition (Figure 17); it now has no inner voice movement, which diminishes any sense of development. The final cadence (Figure 30) in bar 135 is a 6 x 3 *tisra nadai mukthayam* that uses free harmony and chromaticism with each triplet repetition.

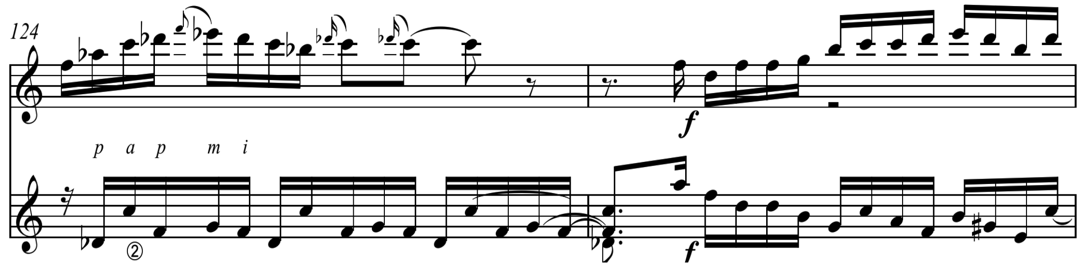


Figure 29: Two cadences are demonstrated here: bar 124 shows a *mukthayam* of 5 x 3 and bars 125–126 show a Western V-I cadence

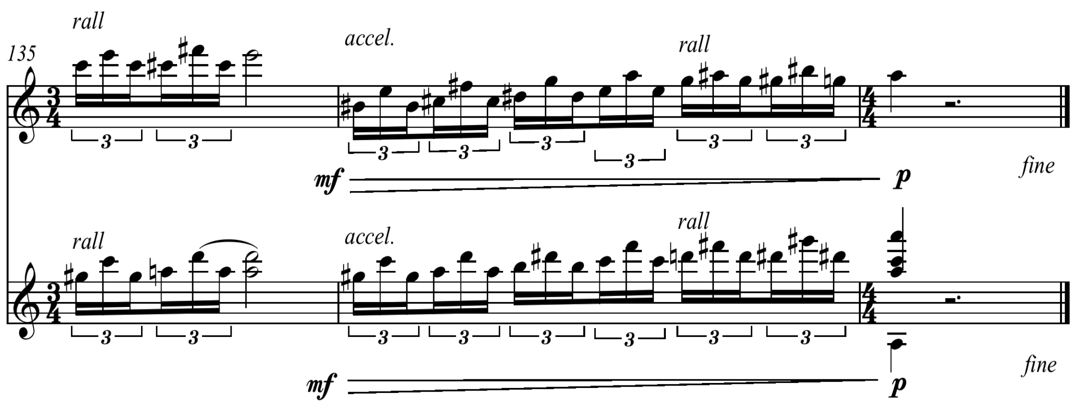


Figure 30: A mukthayam of 6 x 3 with no melodic repetition

The form of *The Wait* is ternary, like a large *tihai* (see Table 8). The A sections have a more Western and harmonic approach and the B, C and D sections explore and develop Indian rhythmic concepts.

Table 8: Compositional form of *The Wait.*

Compositional Structure of *The Wait* for Flute and Guitar	
A section	Western harmony with the introduction of *mukthayams*
B section	Shifting ostinato patterns ending in a complex *gopucca yati*
C Section	Western harmony in the style of *alap*
D Section	Static modal variation exploring *mukthayams* in *khanda nadai*
A Section	A section repeat with slight variations and coda

Chapter 9: Analysis: Hamsadhvani and Yaman for Classical Guitar and Flute

This composition uses two ragas, *hamsadhvani* and *yaman*. *Hamsadhvani* is a popular South Indian raga and the name translates as 'the sound of swans'. *Hamsadhvani* is a pentatonic scale and is a *janya* raga, meaning it is a derived scale from one of the 72 *melakarta* ragas. The ragas it could be derived from include the *Dhirasankarabharanam* 29 major scale, the *Mechakalyani* 65 Lydian scale, and the *Chitrambari* 66 and *Latangi* 63 scales, both of which have no equivalent in Western music but contain the notes of *hamsadhvani.* The notes of *hamsadhvani* are the notes of a major ninth arpeggio.

Yaman is perhaps one of the most fundamental ragas in Hindustani music. The characteristics of this raga are equivalent to the Western Lydian scale, but in Indian music, it is treated quite differently. The *yaman* ascent usually omits *sa* and *pa*, which transform ascending patterns into a minor pentatonic scale starting on the major seventh (Figure 31)*. Yaman* starting notes often begin on low *ni* and *dha*: *ga* and *ni* are frequently voiced in compositions and *ma, sa* and *pa* are often sustained and end phases. Sometimes *yaman* uses the natural *ma*, making it equivalent to the Western major scale, although this is rare in *yaman* today. Indian treatises document this raga around 1570 and, interestingly, there are some similar musical practices of the Lydian scale in Western music. For example, the Lydian mode was used in the Middle Ages and Renaissance periods with the addition of the natural fourth. In jazz, George Russell's book *The Lydian Chromatic Concept of Tonal Organisation* deemed the Lydian mode more natural because the sharp fourth appeared earlier in his conceptual approach than the natural fourth (Russell 1953). Many jazz musicians also use a minor pentatonic scale starting on the seventh of a major seventh chord to emphasise the upper extensions of a Lydian chord. This scale in Western and Indian music has many theoretical similarities but many differences in the way it is used and practised in improvisation and composition. This raises the question: Do *yaman* and the Lydian scale have the same historical origin or did they evolve independently?

9.1 Lydian and Yaman Relationships

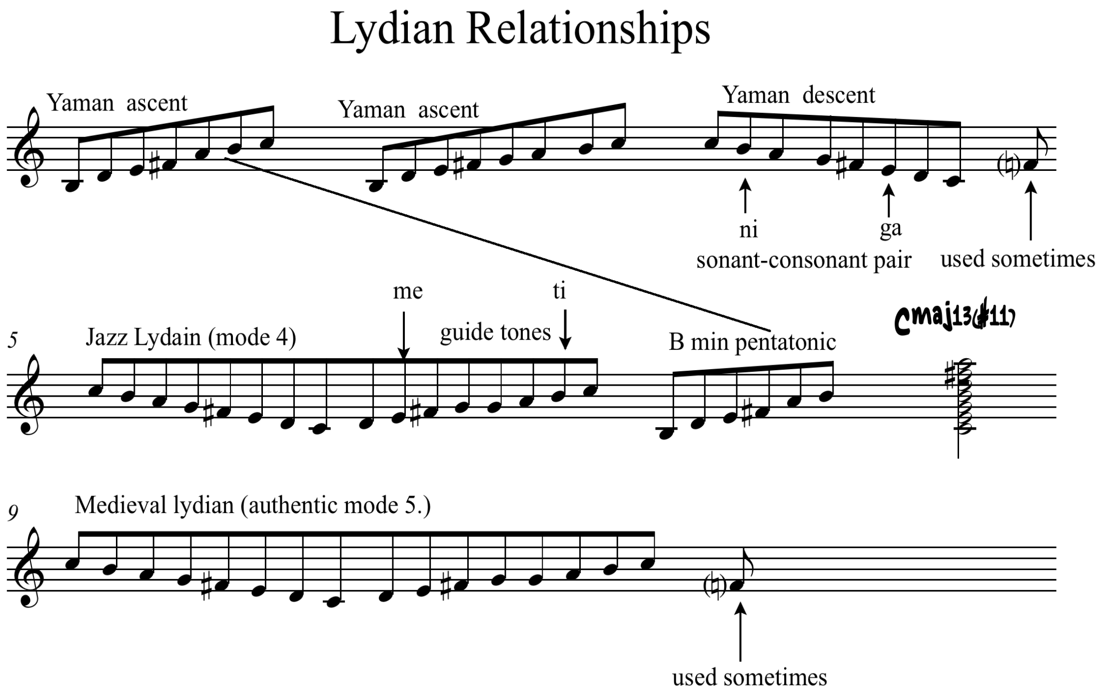


Figure 31: Intercultural and historical relationships relating to the Lydian scale.

As there is little history on this subject, it might not be possible to accurately trace the origin of the Lydian scale and *yaman* and to know whether they evolved independently in India and the West or whether they have the same origin. *Hamsadhvani* was said to be created by Ramaswami Dikshitarwas in South India and was introduced into the Hindustani system around 1890, where it also became very popular. Compared to most ragas it is very simple, the ascent and descent being the same. This raga is played in the early evening and has an emphasis on *re*, which is often approached from *ga* (Bor, 2002, p. 80).

9.2 Alap Introduction

Alap is a concept that introduces a raga very slowly, outlining only a few notes at a time, allowing the performer to express the *vadi* notes and important phrases (Figure 32). *Alap* is always played at the beginning of a composition and is given the highest order in Indian music; it can often express or invoke serene or spiritual sentiments. How an *alap* performance might trigger these sentiments in a listener is a philosophical discussion not entered into here. However, it is worth mentioning that philosophy, religion, culture and music have always been deeply intertwined with Indian music. This musical knowledge has been passed on through family traditions and not governed by educational institutions.

One important feature of *alap* is that it is unmetered, which presents a problem for analysis because both *tala* and bar lines assume the existence of metrical frameworks. There are many ways in which *alap* can be performed, the most common characteristic is slow unmetered and rhythmically free time. What makes *alap* so attractive musically and theoretically is that metaphorically and culturally it represents an unfolding of being and existence through musical form. It is a gateway to experience a level of consciousness between *naad*[7] and musical form. It is music at a very fundamental level that evolves into form and structure through melody alone and gives a sense of emptiness evolving into beingness and space. For those of a less philosophical bent, a good *alap* is the recognition of a skilled performer who can improvise coherent spacious and musical ideas and share them in a socially understood musical context.

The *alap* exposition of this composition is like a traditional *alap* and accounts for and reflects on consubstantial Indian discourses. It is important to understand the consubstantial practices themselves but not necessarily seek the meaning of these things in the music itself; rather, let them direct the mind to an understanding of *naad*, which is—*beyond.* Western music is not dissimilar in that the conditions that govern and produce Western music are also consubstantial with the music itself. Western music also uses similar aesthetic practices to *alap*. For example, a common practice is to begin *alap* on the tonic in the middle register and slowly introduce other notes; similarly, many Western music styles do this. Although, what this compositional process and aesthetic reflect in Western music is different to the Indian aesthetic. The Indian musical aesthetic directs itself towards '*naad*', a non-dualistic primordial sound, a vibration within the mind (Mohanty, 2000, pp. 128–129).

[7] *Naad* translates as primordial sound that exists metaphysically. It is the sound of the cosmos and of human consciousness, a sound that transcends space and time, which has no beginning or end.

Figure 32: *Alap* introduction using minimal and sustained notes, slow tempos, variations in *nadai,* and sustained *vadi* notes *re* and *ni.* All help set the atmosphere of the *alap*

The concept of *vadi* is where the most important notes in a raga are introduced: an equivalent in Western music would be something like the guide tones of a chord. In *hamsadhvani*, the *vadi* note is *re*, which is held or articulated for a considerable time before returning to *sa.* The same concept is used in Figure 32 where F# in bar 3 resolves to E with added harmony.

In Indian music, there are many instrumental techniques that allow sustained notes and articulations to sound interesting. Western musicians lack some of these Indian performance techniques. For example, *gamak*— 'shaking of the sound'— used by Indian vocalists and imitated by instrumentalists is a technique not used in Western music. Many of these techniques are not possible on Western instruments, and if they are possible they take years to learn well. On stringed instruments, executing these difficult techniques requires coconut oil on the fingers to reduce friction. Because of the lack of pitch-altering ornaments that the flute and guitar can manage, I have kept this *alap* brief.

In bars 4–14, the composition gives the illusion of 'free time' by chords overlapping bar lines, using different *nadai,* rubato and a slow tempo. All these techniques contribute to the *alap* aesthetic. *Jor* is another form of *alap* where unmetered time is introduced before the *asthai*. I have used this idea in bars 14–17 (Figure 33): here, time is introduced but *tala* and time signature are not intended to be discernible.

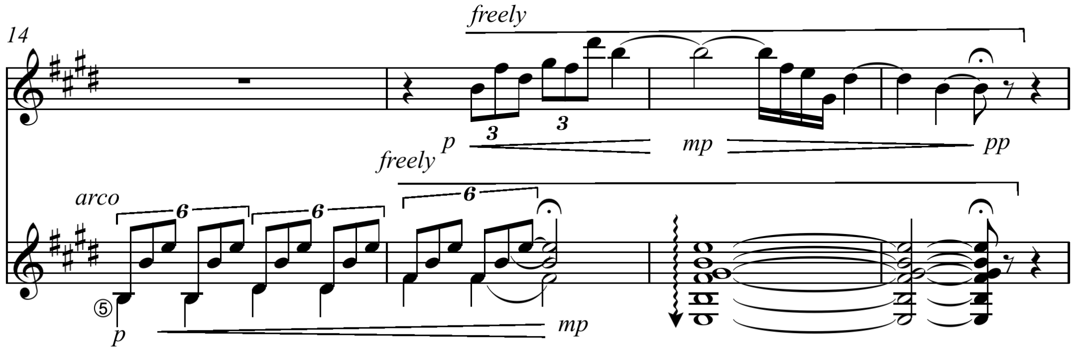


Figure 33: *Jor* is where time is introduced with no clear metre

In bars 18–19 (Figure 34), time is clearly structured within the bar; the flute and guitar, however, go straight back into a freer rhythm at bar 20 with the guitar playing in half notes and the flute in dotted half notes. At bar 26 the alternating between instruments continues rhythmically, more energised but still not clearly metred. It is not until bar 29 (Figure 35) that the rhythm is clearly structured within the bar.

Figure 34: *Jor, jhala* and *alap* combined into a transition passage that leads into a more rhythmic section

An important improvisation technique used in *alap* is *jor* (Figure 35). This technique is used by sitar and sarod players and involves the constant repetition of melody notes played against the *chikari* strings. It is often unmetered but can be very rhythmic and syncopated. Similarly, the classical guitar can do this quite easily by using the top E and B strings as *chikari* strings and play melody notes on the lower D and G strings. I have used this technique in bars 30–31 (Figure 35). An effective use of *jor* combined with *gamaka* can be used, creating an intense glissando effect on the fretted strings. *Jor* is used mainly in *alap,* Here, however, I have used it deliberately as a transition passage between unmetered and metred sections of the composition.

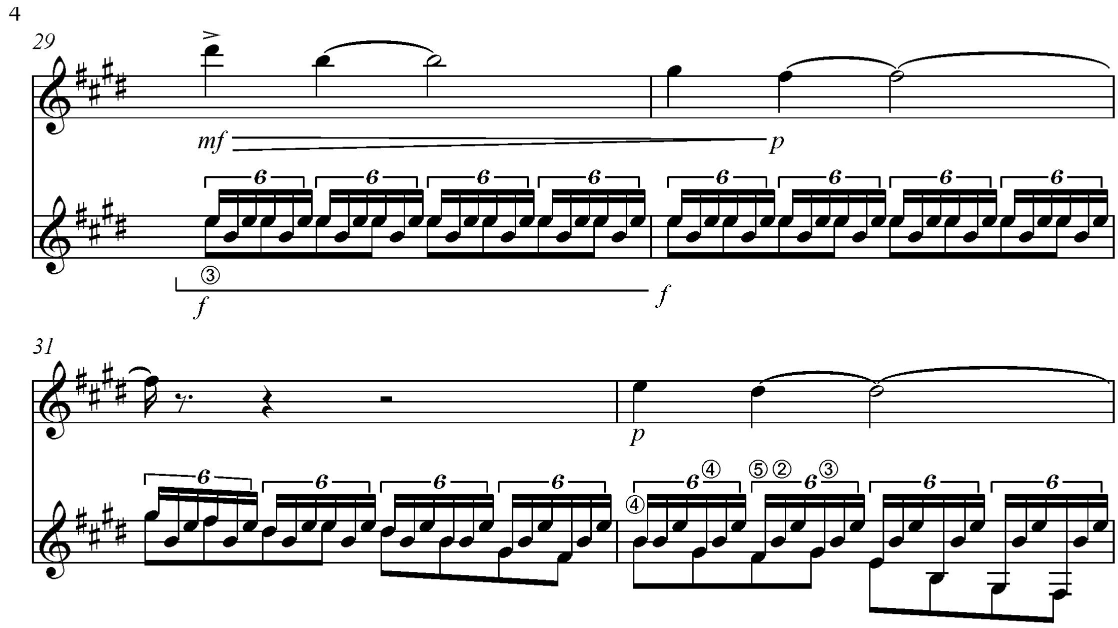


Figure 35: The guitar combines *jor, gamaka* and drones B and E, all functioning together as a rhythmic accompaniment to the flute

At Figure 36, the *asthai* begins with a metred accompaniment pattern in the guitar and the flute repeats the same ascending *tisra nadai* pattern in three different speeds (bars 35–41). The guitar is now more rhythmically defined within the bar structure or *vibhag*: when drone strings and melody notes are articulated within *vibhag* structures, the technique is called *jhala.* The *jhala* rhythm in the guitar allows a stable rhythmic base for the flute to explore more rhythmically complicated *nadai* patterns against the accompaniment. *Jhala* is usually used for solo playing but works very well as a solid accompaniment pattern.

The guitar also functions like a *tanpura.* For example, the four strings of the *tanpura* are tuned to low octave *sa*, middle octave *sa* and low *pa*. The guitar part functions melodically in exactly the same way with the added extra *ni* on the third string; however, the *tanpura* is not usually played in *tala*. In this accompaniment, the guitar functions like a *tanpura* but is played in the style of *jhala* (Figure 36, bar 35).

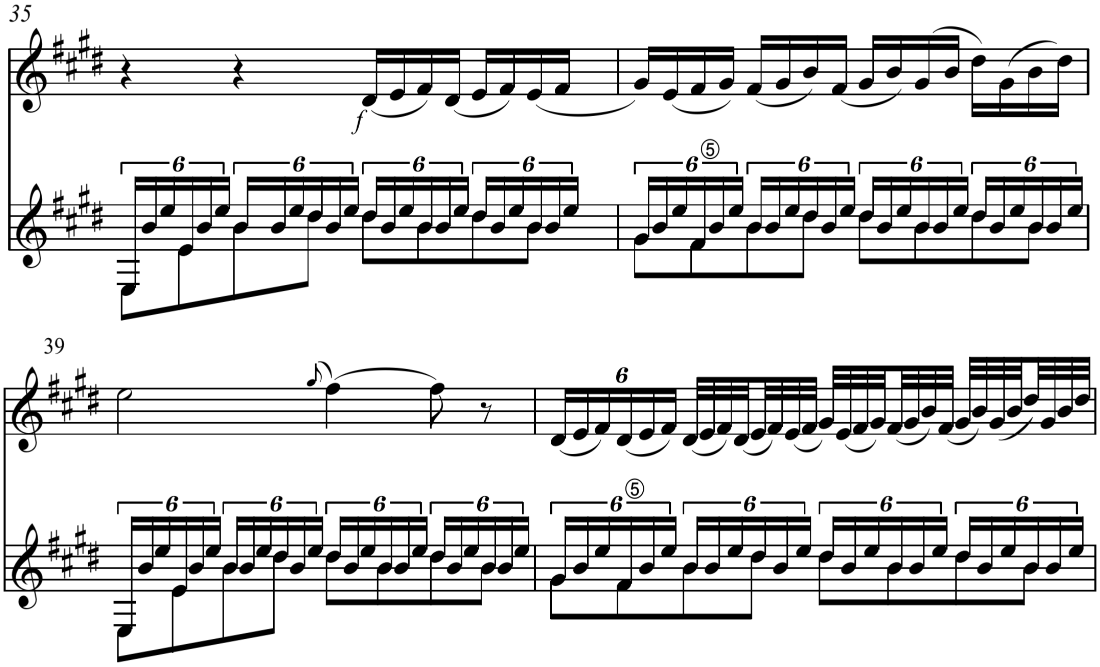


Figure 36: *Jhala* rhythm accompaniment in the guitar outlining a typical *tanpura* pattern. This gives freedom to the flute to explore various *nadai* patterns against it

Up to bar 41, the composition has been entirely in *hamsadhvani*. In Indian music, it is unusual to combine two ragas in the same composition. However, this is becoming more common today, especially with related ragas. Historically, the task has been to sustain interest in one *raga*, this is done not only through form but also through a wide variety of pitch-bending techniques. Originally, these pitch-bending techniques were out of tune to Western ears and it was not until extensive research was conducted that scholars realised that the oscillation, flattening and sharpening of notes was intentional by performers and expected by audiences. Western music generally concentrates on the dead centre of the note. In Indian music, pitch is much more hierarchical and has a fluid relationship to other notes and groups of notes that come before and after (Holroyde, 1972 pp. 136–138). It is difficult to translate the inflexibility of the Western octave and the elasticity of Indian tones and *srutis.* What is clear is that through the execution of *srutis* the ear is constantly being drawn to an imaginary or real note; this does not happen to the same extent in Western classical music. Also, Western musicians are not equipped with a wide range of techniques and instruments to do this. The consequence of this is that writing a Western composition entirely in *hamsadhvani* could result in failure if relying on centred pitch alone. What I have tried to include in this composition, as a compensation for this lack of pitch ornamentation, is rhythmic complexities like *nadai, mukthayam* and *korvai*, which do not explicitly need pitch ornamentation.

In bars 41–43 (Figure 37) the flute introduces *yaman* (E Lydian). The *yaman* rule of not playing *sa* on the ascent was not adhered to here but the characteristic *vadi* notes *pa* and *ma* are held longer in the flute, which is characteristic (bars 41–42). The guitar mostly avoids the notes *sa* and less so *pa,* keeps a consistent quaver pattern and avoids any pitch hierarchy, which allows the flute to explore and sustain the *vadi* notes *ga, ma* and *pa.*

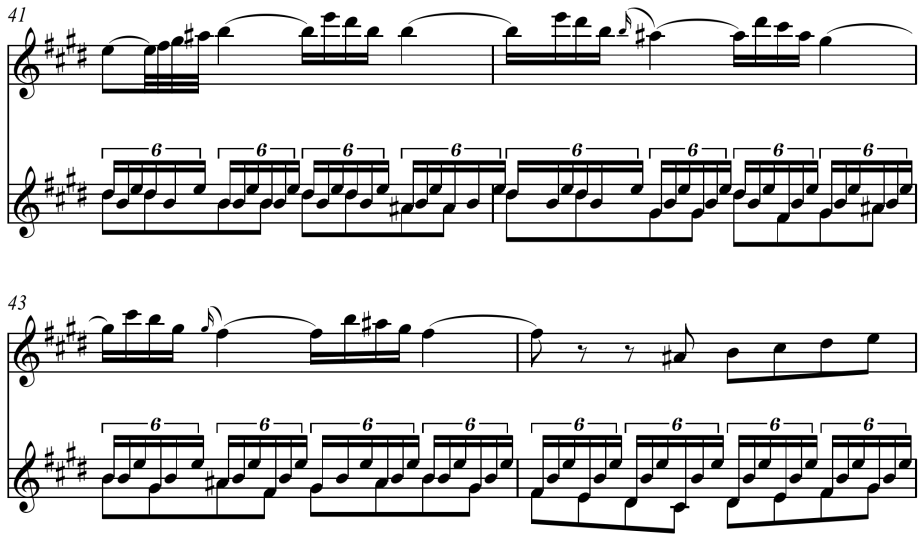


Figure 37: Characteristic phrases taken from *yaman*, i.e., sustained use of *ma* and *pa* and the avoidance of *sa* in the guitar part

In Figure 38, the flute uses the *nadai* concept. The first eight semiquavers at A are transformed into semiquaver triplets at B with the exact same pitches, and with four semiquavers added at bar 45, C. The motifs B + C are added together to form D, which is repeated as a tonal sequence in the second half of bar 46. In bars 47–48, the flute has rhythmically transformed E into F using exactly the same pitches and now in semiquavers. To maintain this sequence in semiquavers at F, the time signature changes to 3/4. The guitar accompanies the flute at F with a polyrhythm of three against four. This *tisra nadai* pattern in the guitar helps grammatically connect to the previous semiquaver *tisra nadai* patterns at letter E in the flute. It is worth noting that multiples of three in Indian terminology are admissible, these different *nadai* can be referred to as an extended rhythmic family. For example, when using *konokol* syllables, *ta ki ta* can refer to anything in groupings of three.

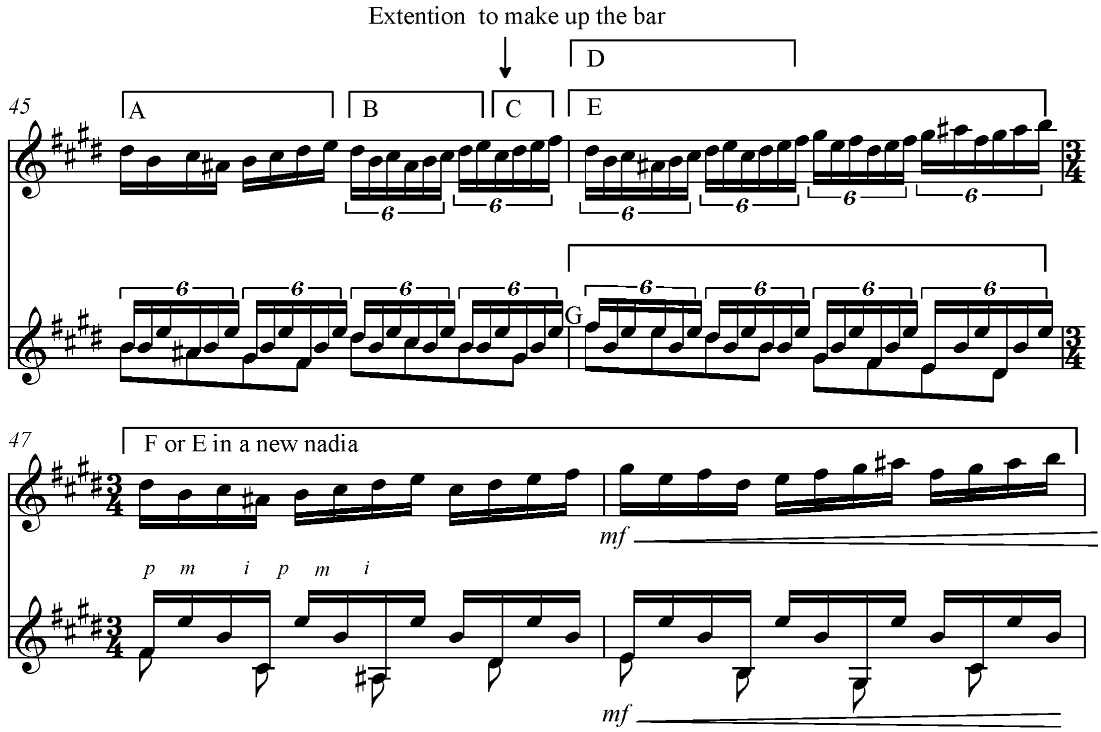


Figure 38: A melodic cell transformed into different *nadai* patterns and polyrhythms

In bars 53–56 (Figure 39), the harmony pivots around the dominant of the dominant (F#7) resolving to B7 in bar 56. This section has moved away from Indian rhythmic concepts and uses a more Western compositional approach using chromaticism and dominant–tonic relationships. Modal interchange is used between B major and E major and/or E Lydian and E Ionian. It is slightly ambiguous because there are only a few instances of dominant–tonic relationships up to bar 71. To reductio ad absurdum, an Indian musician not versed in Western music might hear this section as sometimes *hamsadhvani* or *yaman*, with chromatic notes being oddities or mistakes; it could also be heard as a different raga entirely. Moreover, musical theoretical analysis is not always appropriate for cross-cultural music, as socially learnt conventions are strong determinants of how we hear and understand music.

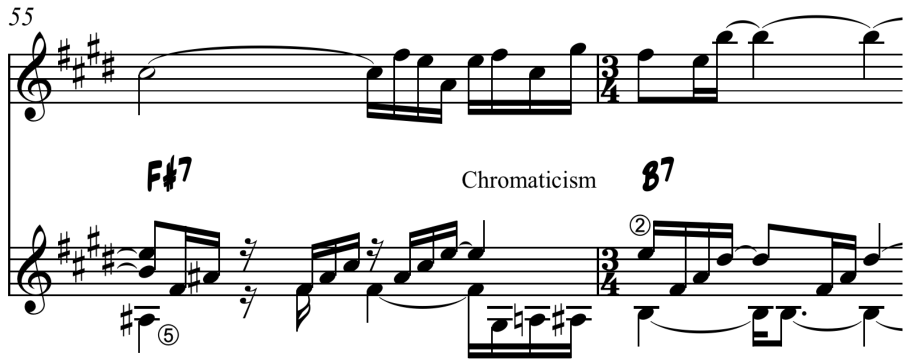


Figure 39: The introduction of chromaticism and dominant–tonic relationships

Figure 40 is based on the *mukthayam* of (9 x 3) or (*ta.di.gi.na.tom*) x 3 and is a set-up for a long *korvai* beginning at bar 60. The beginning of each phrase is intact; however, I have manipulated the original phrase with rests and diminution. To the performer, it is probably not a recognisable *mukthayam* but its beginnings were straightforward. In the context of this composition, some musical manipulation was needed.

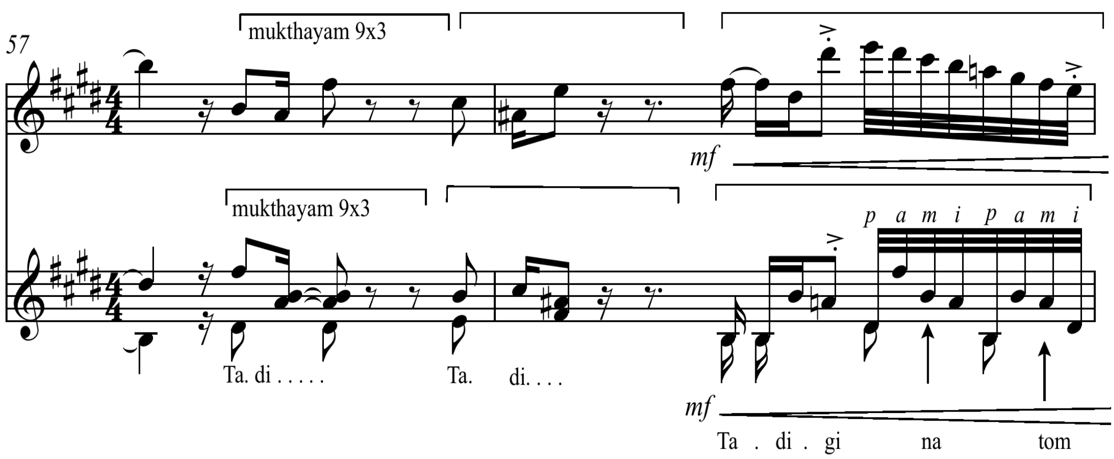


Figure 40: A *mukthayam* of (9 x 3) with freely added *karvai* and diminution

Table 9 in Section 9.3 demonstrates the most rhythmically complex aspect of this composition. It is based on a *korvai* in *adi tala, chatusra nadai* and takes six *avartas* to complete and ends with a *tisra nadai mukthayam.* In Western terminology, this means a rhythmic calculation in 8/4 time, which takes six bars to complete, has 48 beats in total and ends with a *mukthayam* in triplets. I have outlined this *korvai* using Indian and Western notation so the geometric structure is visible. Visualising as well as hearing *korvais* greatly aids in the memorisation of complex rhythmic patterns. At a fundamental level, all the performer needs to do is visualise and remember patterns chunked in groups of three.

There is a dovetailing of binary and ternary structures in this *korvai*. For example, line 4 in Table 9 functions as binary if you think of it as part of lines 1, 2, 3 and 4, and ternary if you think of it as part of lines 4, 5 and 6. Line 6, columns C and D, functions as part of two different ternary *mukthayams* and is pivotal in that it ends one *mukthayam* and begins the other. Lines 9–17 function as a large ternary structure, all three sections being exactly the same phonetically and the only variation being that lines 15–17 are now in *tisra nadai* not *chatusra*. Lines 9–17 can also be considered as (3 x 3) ternary structures like a *chakradhar tihai* that ends one beat before the *sam. Korvais* like this are fractal but show gravitational pull towards the number three because it makes them easy to remember. Because the number three is so pervasive in these structures, it begs the question of whether is it a socially constructed idea, or whether there is a deep connection between the number three, memory and other phenomena. If so, how did this evolve and from what? Mathematicians since Pythagoras have viewed the world as numbers external to human reality. Alternatively, the human mind may only be able to think of reality in these two ways: a reality we construct or an overriding external reality based on numbers of which we are part and endlessly trying to understand. Whatever we choose to believe, the process of uncovering new phenomena gives humans a purpose and a form of comfort from chaos and not knowing.

9.3 Using Korvais

The following k*orvai* is taken from *The Art of Konnakkol* by Trichy Sankaran (Sankaran, 2010 p. 57). In Figure 41, bars 59–71, the flute and guitar play in rhythmic unison but use different pitches primarily in *yaman* with an occasional natural fourth in the guitar part. This is historically an accepted way of treating *yaman* and is also a typical modulation in Western music—that is, E major to B major. Table 9 and Figure 41 are examples of the same *korvai* in Indian and Western notation. The Indian notation depicts the *gopucca yati*, visually demonstrating its diminutive geometrical structure, which is not as clear in Western notation. The *aksara* columns show how these phrases can be grouped mathematically. The *konokol* syllables under the flute part and the geometric structure in Table 9 show how I have adapted this *gopucca yati* into Western notation.

Table 9: *Korvai* demonstrating a *gopucca yati* using numbers and *konokol* syllables

	Bar	A	B	C	D	*Aksara*	*Aksara*
1	59	Ta . ta ri	.ta jo nu	Ta ka ta ri	. ta di mi	4	
2		Ta ka ta ri	.ta jo nu	Takitarikitataka	Tam ….	4	
3	61	Ta . ta ri	.ta jo nu	Ta ka ta ri	. ta di mi	4	16
4		Ta ka ta ri	.ta jo nu	Takitarikitataka	Tam ….	4	
5	63	Ta . ta ri	.ta jo nu	Takitarikitataka	Tam ….	4	
6		Ta ka ta ri	.ta jo nu	Takitarikitataka	Tam ….	4 (2 +2)	
7	65			Takitarikitataka	Tam …	2	10
8				Takitarikitataka	Tam ...	2	
9	66			Takitarikitataka	Tam.	1.5	
10				Takitarikitataka	Tam.	1.5	5
11	66			Ta di . gi	na tom	1.5	
12				Ta di . gi	na tom	1.5	
13				Ta di . gi	na tom Ta…	2 .5	(1.5 x 3) + 1 = 5.5
14	68			Ta di . gi	na tom	1.5	
15				Ta di . gi	na tom	1.5	
16				Ta di . gi	na tom Ta…	2.5	(1.5 x 3) + 1 = 5.5
17	69	*Tisra nadai*		Ta di .	gi na tom	2	
18	70			Ta di .	gi na tom	2	
19				Ta di .	gi na tom	2	6
20	71					Ta	Total 48

Figure 41: The application of the *korvai* used in Table 9 demonstrated in Western notation

In Carnatic music at the end of a *tani avartanum,*[8] a *korvai* like in Figure 41 will be presented and usually signals the return of the main theme or song. Here all percussionists play an extended *korvai* in rhythmic unison. I have used the same compositional technique here where the guitar and flute play in rhythmic unison but use different pitches, ending one *aksara* before the *sam.*

The recapitulation at bar 75 (Figure 42) begins repeating *nadai* patterns heard in the exposition and development. The flute phrases are longer now and extended over a larger range accompanied by the guitar using the exposition's *tanpura* pattern, as in Figure 36. Bar 79 (Figure 43) introduces a *chakradhar tihai*; this is a standard type of Hindustani *tihai* repeated three times ending on the *sam.*

[8] A complex collective percussion composition.

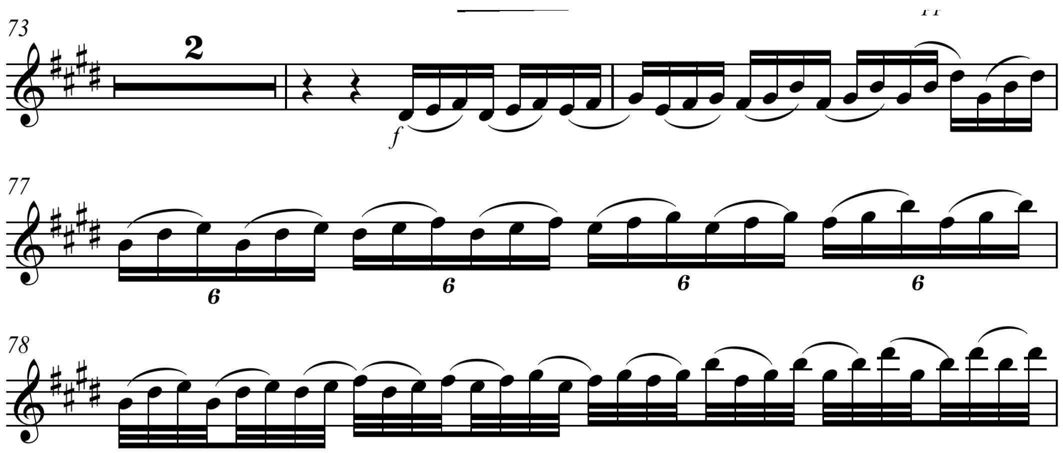


Figure 42: Extended *nadai* patterns used in the exposition

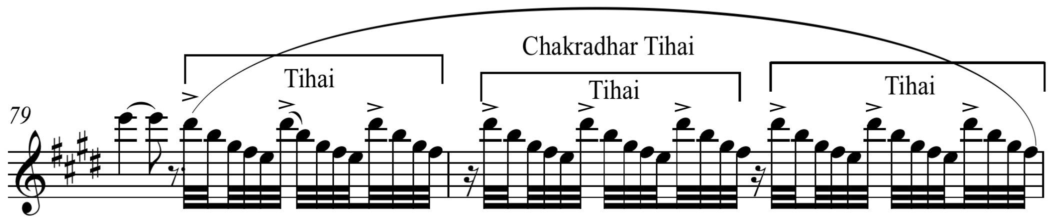


Figure 43: *Chakradhar tihai* (5 + 5 + 5) x 3 ending on a *sam*

Bars 86–88 (Figure 44) involve a progression of *tisra nadai* patterns in four different speeds—semiquaver triplets, semiquavers, triplets and quavers. The decreasing speed of these *nadai* patterns functions like a written out rallentando, which brings the composition back to the exposition's *alap* feel and tempo. The *nadai* patterns could have been written as metric modulations or in different time signatures. However, I find it more satisfying to feel different *nadai* patterns against a regular pulse because of the relationship this method has to the body (even though aurally there are few differences between the two concepts). Having a metric modulation would mean the musicians would not feel the cross rhythms. For example, bar 86 (Figure 44) could have been written as 12/16 time and bar 87 as four bars of 3/8 time, but doing this would not be effective because I wanted the players to feel the *tisra nadai* patterns against a regular pulse. Bar 89 (Figure 44) begins the recapitulation *alap* in much the same way as the exposition, with each new bar in a different time signature helping displace any sense of *tala* and re-establishing the *alap* aesthetic (Figure 45).

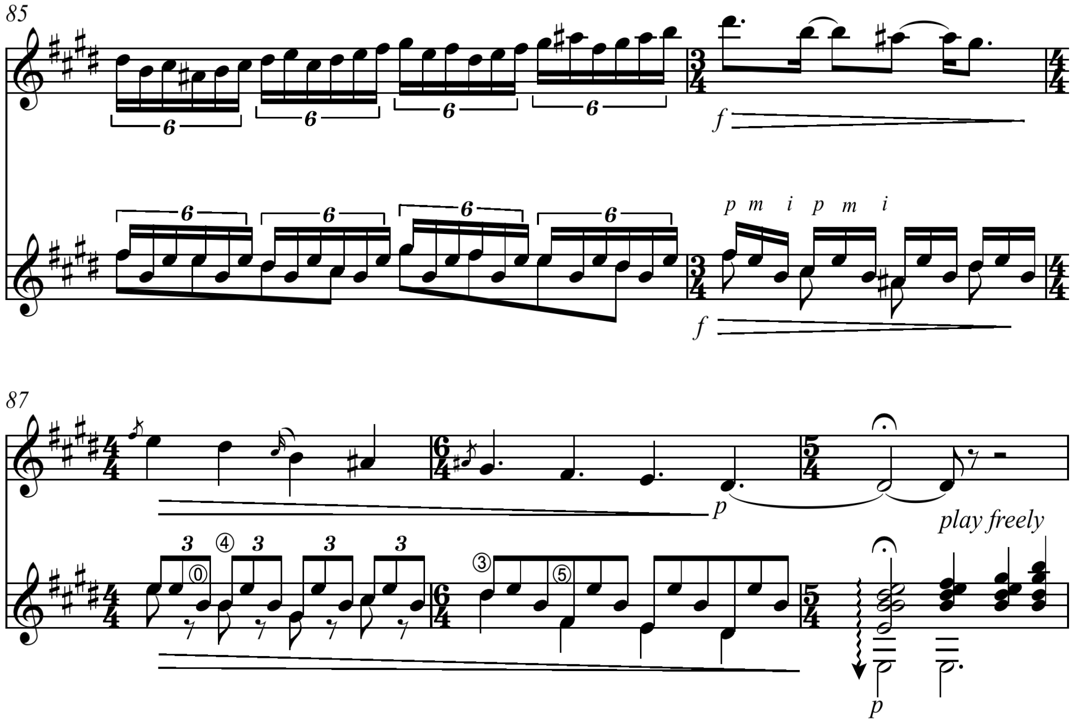


Figure 44: Different *nadai* patterns functioning like a written out rallentando bringing the composition back to the original tempo

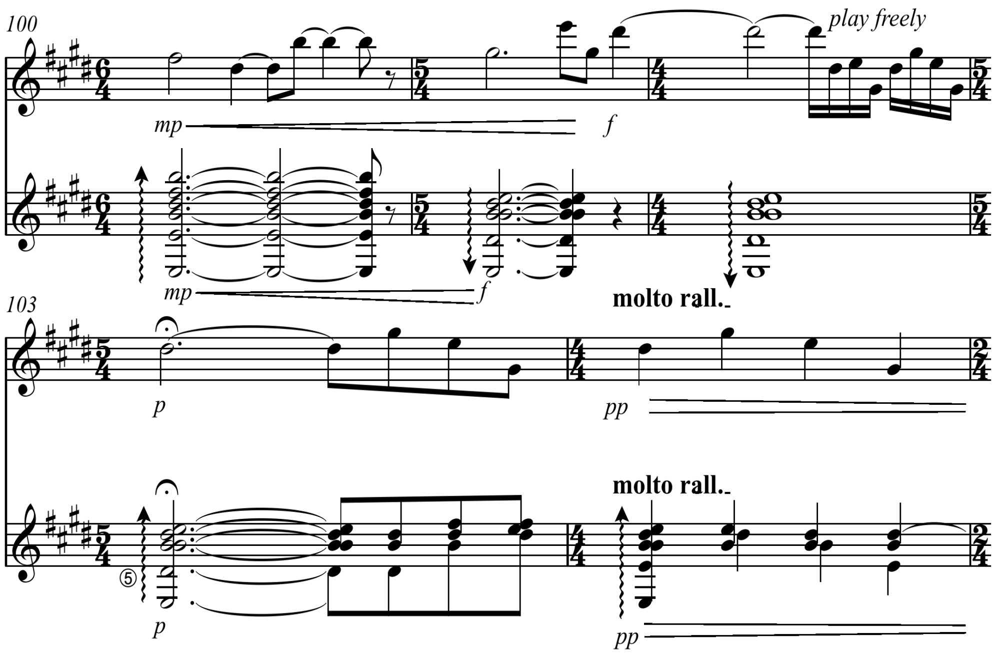


Figure 45: Changing time signatures using rubato, fermatas and long sustained notes help establish the *alap* aesthetic

Chapter 10: Analysis: Miyan Ki Todi for Flute and Guitar

10.1 Miyan Ki Todi Raga

Miyan ki todi is the most popular and important raga of the *todi* family. It is characterised by the *vadi* notes *dha, re* and *ga,* all of which are played very flat. The ascent usually begins on *ga,* and *pa* is often omitted on ascent and sustained at the end of phrases (Bor, 2002, p. 120). *Miyan ki todi* is regarded as an intense and dramatic raga because of its unique chromaticism, that is, *ni, sa, re* and *pa, ma, ga*: there is no comparable scale in Western music (Figure 46).

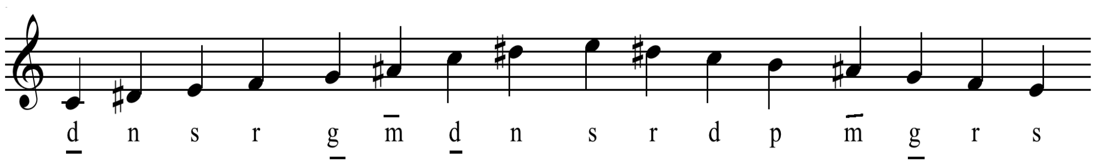


Figure 46: Miyan ki todi raga

The first section begins with *alap,* bars 1–28*.* The guitarist is instructed to play freely on two different chords in *khanda nadai*, which provides a tanpura-like drone to support the flute to freely explore the raga. The introductory flute notes are slowly introduced and hover around *re* and *ga* in bars 2–5 (Figure 47); it is not until bar 11 that *ni* is introduced. I deliberately avoided the flute playing some of the important *vadi* notes that characterise this raga to create ambiguity and more intensity when they do arrive. The *alap* should be played as though time did not exist metaphorically and rhythmically. Despite bar lines being used, they are not necessary but are used as a matter of convenience for the Western performer.

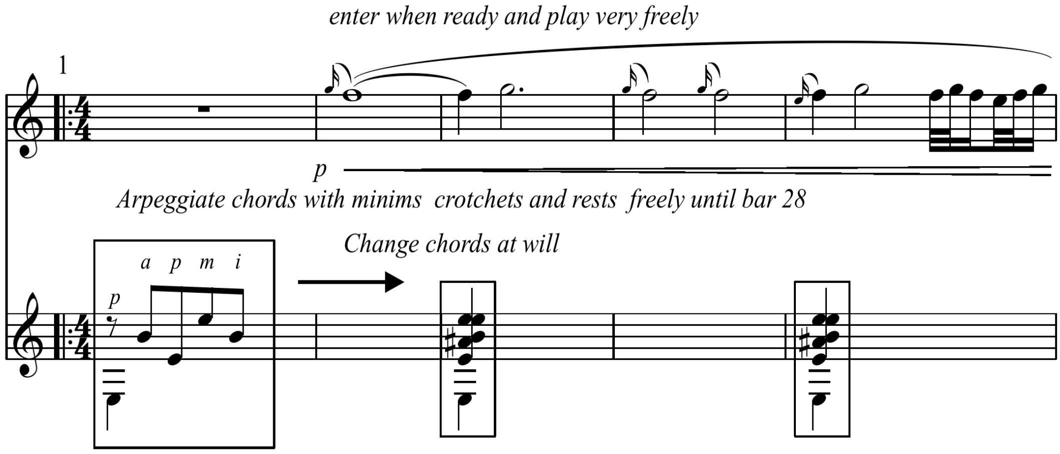


Figure 47: Free arrhythmic *khanda nadai* chordal arpeggios in the guitar and the slow introduction of *vadi* raga notes in the flute help convey the *alap* aesthetic

Time and metre are slowly introduced within bar structures, the obvious indicator of this is rhythmic unison between the flute and guitar (Figure 48, bars 31–41). This is a transition section loosely based on the *jor* concept and links the opening timeless *alap* to the more rhythmic section at Figure 51. Vertical harmony is also introduced here, which I prefer to think of as one or more notes against a drone even when the drone is not present. The absence of harmonic concepts in Indian music is liberating in that it allows harmonisation to take place without being shackled to the vertical concepts of Western harmony. This idea works particularly well in a dissonant raga like *miyan ki todi.* At Figure 49, bar 41, the *alap* section ends with a rhythmic and melodic unison passage with the guitar ending on a chord that includes both drones E and B and all three *vadi* notes *ni, da* and *ma*.

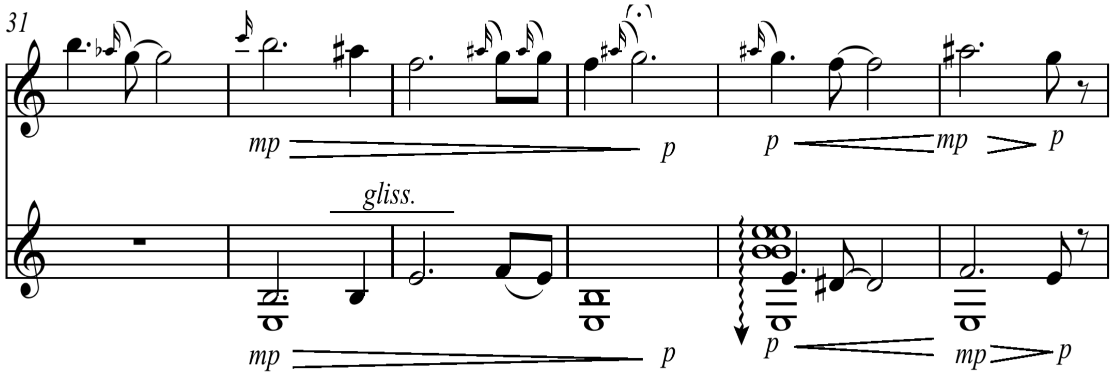


Figure 48: The introduction of time through rhythmic unison and the free use of harmony using the *miyan ki todi* raga

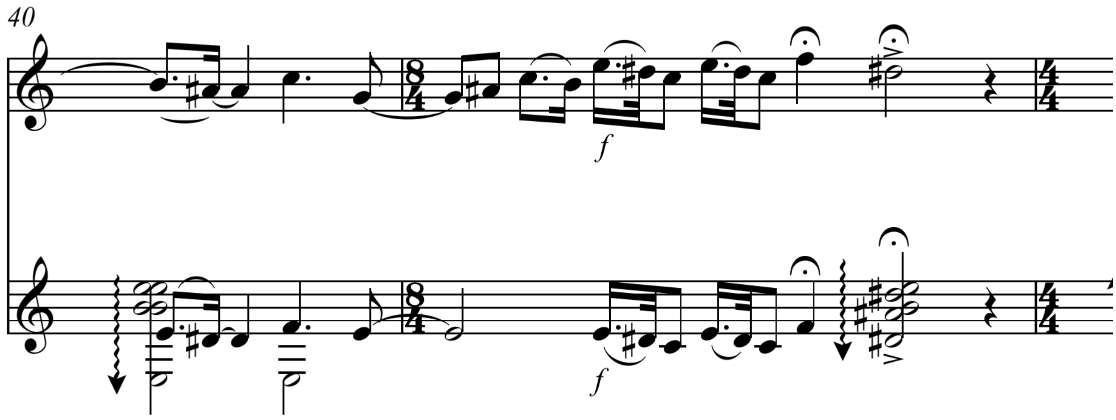


Figure 49: Linking passage between *alap* and *jhala,* ending on a chord that includes drones E and B and all three *vadi* notes *ni, da* and *ma*

10.2 Harmony of the Miyan Ki Todi Raga

Figure 50 demonstrates a Western approach to harmony built on each note of the *miyan ki todi* raga. The relationship of these chords to each other, like in other scale tone harmonies, will have its own special relationship. Using *miyan ki todi* harmony in this way evokes and combines different culturally constructed meanings and traditional music practices.

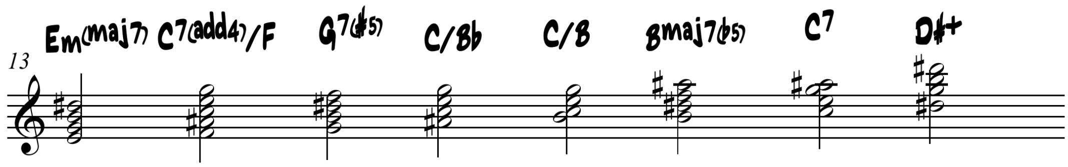


Figure 50: Harmony derived from the *miyan ki todi raga* (enharmonic chord spelling)

The unique melodic outline of this raga is its semitone structure: the semitones are not played consecutively, that is, D#, E and F are played D#, F and E, and C, B and A# are played C, A# and B. This technique is used throughout *miyan ki todi* in both the flute and guitar (Figure 51, bars 45–48). This avoidance of chromaticism is also achieved by ending on *pa* and avoiding *pa* when ascending and descending. The equivalent idea in Western music is the use of non-harmonic tones resolving to a harmony note, used extensively in bebop. Although to a Westerner these two concepts can sound aurally similar, the application of non-harmonic tones to a raga like *miyan ki todi* is not applicable because of the raga's unconventional harmonic structure. If composing without the concept of harmony being involved, it does not make sense to then impose harmonic concepts, although being able to choose, think and compose with and without harmonic considerations has its advantages rhythmically, melodically and harmonically. Being able to compose in both Western and Indian systems is a very good way to experience this freedom.

The next sections in bars 43–58 and bars 59–82 begin with the guitar playing a *jhala* rhythmic figure using mainly drone notes (Figure 51). Each new section develops tension by using denser harmony, a broader melodic range in both instruments, intervallic angular melodies, complex *nadai* patterns and question and answer phrases. The composition develops like this until a climax is reached and is concluded with a *tihai* (Figure 52a and Figure 52b).

Figure 51: *Jhala*-type rhythmic figure using drone notes with interspersed harmonic clusters from *the miyan ki todi raga.* Melodic outline characterised using non-consecutive semitones

Two standard (6 x 3) *tihais* are used to end both the following sections, shown in Figure 52a and Figure 52b. In Figure 52a, the guitar phrases the *tihai* with the flute in half time for the first two phrases and then in rhythmic unison on the last phrase. In Figure 52b, the guitar plays a *tanpura* pattern against the *tihai* in the flute, which has a delayed resolution to *sa* by ending on the *sam* with *re,* giving a characteristic *vadi* dissonance against the drone. In Western composition when using numerically similar *tihais* or *mukthayams* in the same composition, it is useful to employ different *nadai* or rhythmic variations between the parts to avoid repetition.

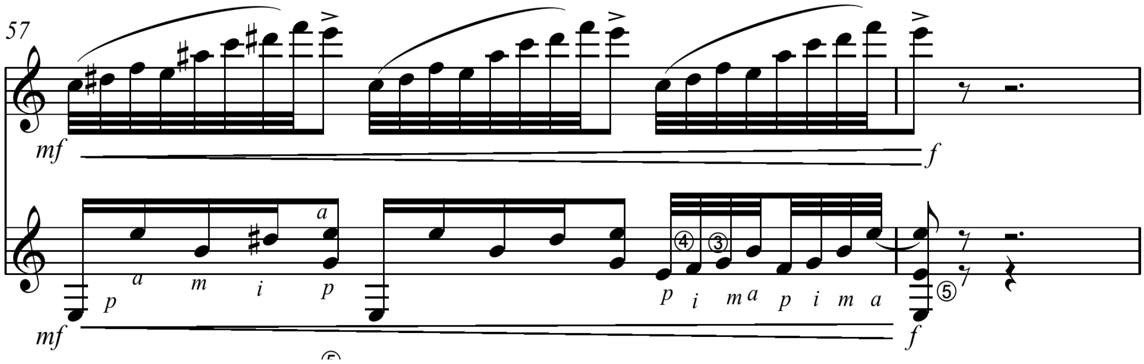


Figure 52a: A *mukthayam* of (6 x 3) with different *nadai* patterns in the flute and guitar ending with a delayed resolution on *sa* in the flute

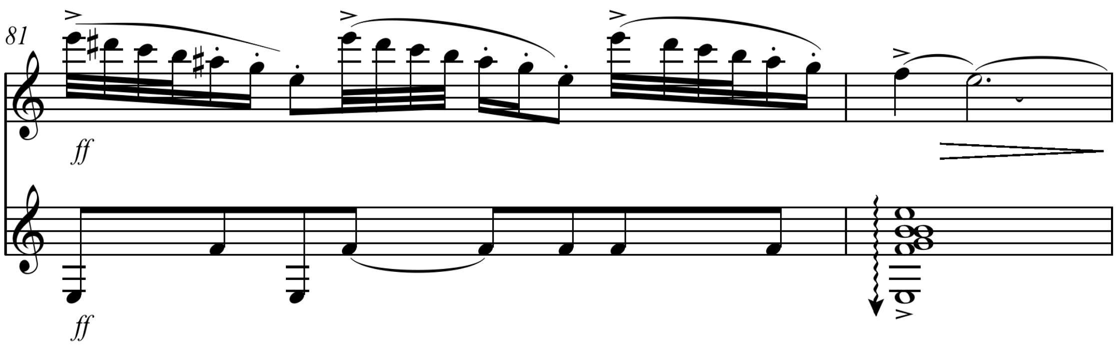


Figure 52b: *Mukthayam* of (6 x 3) in the flute with the guitar playing an accompaniment *tanpura* pattern

Bars 83–93 (Figure 53) are based on an intuitive harmonisation of the *miyan ki todi* raga using the *vadi* notes *ga, ma* and *da* and chords stacked in seconds, fourths, fifths and sevenths. When chords included at least one *vadi* note or a semitone this seemed to keep the character and angular sonority of *miyan ki todi*. Assuming the hierarchical response to pitches in the *miyan ki todi* raga is a culturally conditioned one, it is not so important that I compose by traditional rules seeing that I am composing for a non-specific audience. Although, at the same time, I acknowledge it is important to understand traditional rules to justify breaking them.

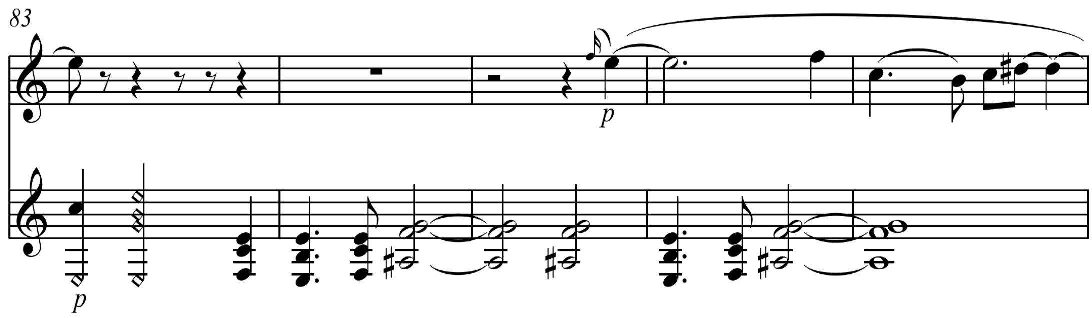


Figure 53: My culturally conditioned harmonic response to the *miyan ki todi raga*. Using at least one *vadi note ga, ma,* or *da* in each chord and harmony stacked in 2nds, 4ths, 5ths and 7ths seemed to keep the flavour of the raga. This idea functioned much like guide tones in Western chords in that it outlined a sonority

In Figure 54, bars 94–101, the guitar arpeggiates using *p, a, m* and *i* across the treble stings using the E and B strings as drones and plays all melody notes on the G string. The G string is perfect for *gamaka* as it is easier to slide on the G string than on the bass strings. This technique combines a three-note chord with a four-note arpeggio pattern allowing the G string to sound like an independent melody as the open and closed strings are juxtaposed against each other. The pattern also helps open-chord voicings sound angular because of the larger intervals. Indian string players often use coconut oil on their fingers because this greatly facilitates the *gamaka* and *jhala* techniques.

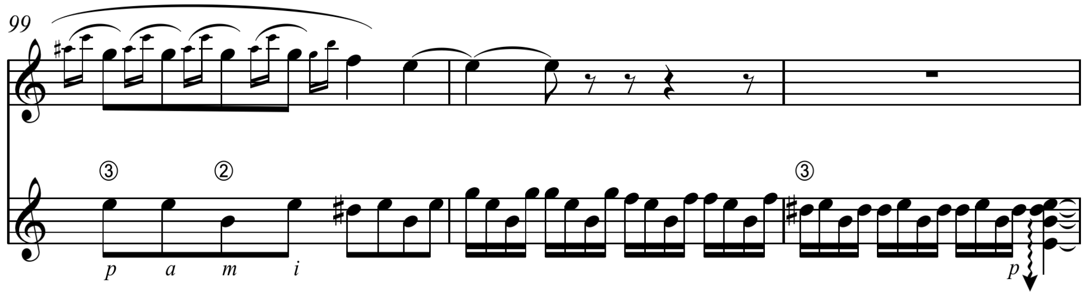


Figure 54: Right-hand arpeggio patterns that sound linear using *gamaka* on the G string and the E and B treble strings as rhythmic drones, creating the illusion of two melodic lines in one melodic voice

Figure 55 involves a variation on a *chakradhar tihai*. It was originally based on a *mukthayam* of (10 x 3) x 3. It eventually became ((7 + 3 *karvai*) x 3) + ((7 + 3 *karvai*) x 3) + ((7 + 4 *karvai*) x 2) + 7 + 3 *karvai,* expanding the last phrase to fit the time signature and land on the *sam* (making reference to *srotovaha yati)*. *Nadai* variations were also added to develop each repetition. The first *mukthayam* bar (102) is rhythmically identical in all three phrases in both the flute and guitar parts. The pitch is also repeated except for the groups of three in the flute where the first note of each group ascends by one scale degree (A#, B and C; Figure 55, bars 102–103). The guitar in the second *mukthayam* bar 106 displaces the chords by a semiquaver and adds harmony. In all three *mukthayams*, the flute takes responsibility for the *nadai* variations, except in the very last phrase in bars 108–109, where both the guitar and flute play in double time and in rhythmic unison. Table 10 outlines the basic structure of these *mukthayams* in *konokol.*

Figure 55: ***Chakradhar tihai*** **((7 + 3** ***karvai*****) x 3) + ((7 + 3** ***karvai*****) x 3) + ((7 + 4** ***karvai*****) x 2) + (7 + 3** ***karvai*****) Sam…. + 3 + (7 x 3)** ***sam*****. Note: arrows indicate down beats and brackets indicate** ***mukthayams***

Table 10: Srotovaha yati, chakradhar tihai followed by a mukthayam.

Original Idea (10 x 3) x 3		
(7 + 3 *karvai*) x 3	Bar 102	Ta. di. gi na tom ta (ki) ta x3
(7 + 3 *karvai*) x 3	Bar 103	Ta. di. gi na tom ta ki ta ta ka x3
(7 + 4 *karvai*) x 2	Bar 106	Ta. di. gi na tom ta ka di mi x2
(7 + 3 *karvai*)	Bar 107	Ta. di. gi na tom …
Sam and transition passage	Bar 108	Tam …. Ta ki ta Ta . di. ta ri (etc.)
7 x 3 *mukthayam*	Bar 108	Ta. di . ta ri ki ta ta ka x3
Sam	Bar 110	Tam

10.3 Gopucca Yati

Bars 110–117 comprise a transition passage that connects the previous *mukthayam* shown in Figure 55 to the following *gopucca yati* beginning at bar 118 (Figure 56). Here, the guitar sets up the *gopucca yati* by using two *mukthayams* in a rhythmic palindrome in bars 116–117. Table 11 demonstrates the rhythmic palindrome and *gopucca yati* in both *konokol* and mathematics; this helps both with the visualisation of its geometric structure and the memorisation of its patterns.

Table 11: *Gopucca yati* 7 x 4 + 6 x 4 + 5 x 4 + 3 x 4 + 2 x 4 +1 x 4 set-up using two *mukthayams* in a rhythmic palindrome

5 x 6 *Mukthayam* Guitar Set-Up in Rhythmic Palindrome	Bars 116–117	Ta di gi na tom x 6
Gopucca yati		
7 + 7 + 7 + 7	Bar 118 Flute	Ta. di. ta ri ki ta ta ka x 4
6 + 6 + 6 + 6	Bar 119 Flute	Ta. di. ki ta ta ka x 4
5 + 5 + 5 + 5	Bar 121 Flute	Ta di ta ri ki ta ta ka x 4
4 + 4 + 4 + 4	Bar 122 Flute	Ta di ki ta ta ka x 4
3 + 3 + 3 + 3	Bar 123 Guitar	(Ta ki ta) x 4
2 + 2 + 2 + 2	Bar 124 Guitar	(Ta ka) x 4
1 + 1 + 1 + 1	Bar 124 Guitar	(Ta) x 4
Sam	Bar 125 Guitar	Tom

Figure 56: *Gopucca yati* (see Table 11) with its set-up of two *mukthayams* in a rhythmic palindrome (3 x 5) x 2 at bar 116

The final *tihai* I learned from Samuel J. Dass, which I transformed into a *chakradhar tihai.* I have written out the original tihai (7 + 7 + 7) in bar 3 and the *chakradhar tihai* in bars 1–3 (Figure 57a). The structure is not easily recognisable in the score because of the added harmony in the guitar, the *nadai* patterns in the flute and one *tihai* phrase missing completely at the end (Figure 57b). What makes it difficult to recognise is the absence of the third and sixth group of sevens (small brackets). The listener hears a false cadence once the second *tihai* begins. This type of *tihai* is also called *nauhar tihai*, meaning the *tihai* has nine elements (7 + 7 + 2) x 3. Each *tihai* repetition feels like it is going to resolve but the absence of the *sam* on the first beat of each bar allows the pattern to begin again. This expectation is only resolved in the very last *tihai* phrase, where the listener can hear the *tihai* in its original form of (7+ 7 + 7).

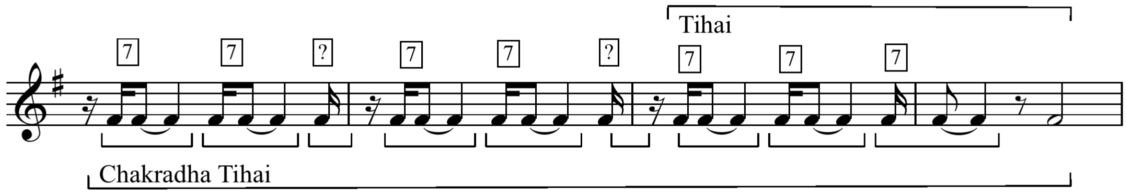


Figure 57a: *Chakradhar tihai* or *nauhar tihai* in full (7 + 7 + 7) x 3

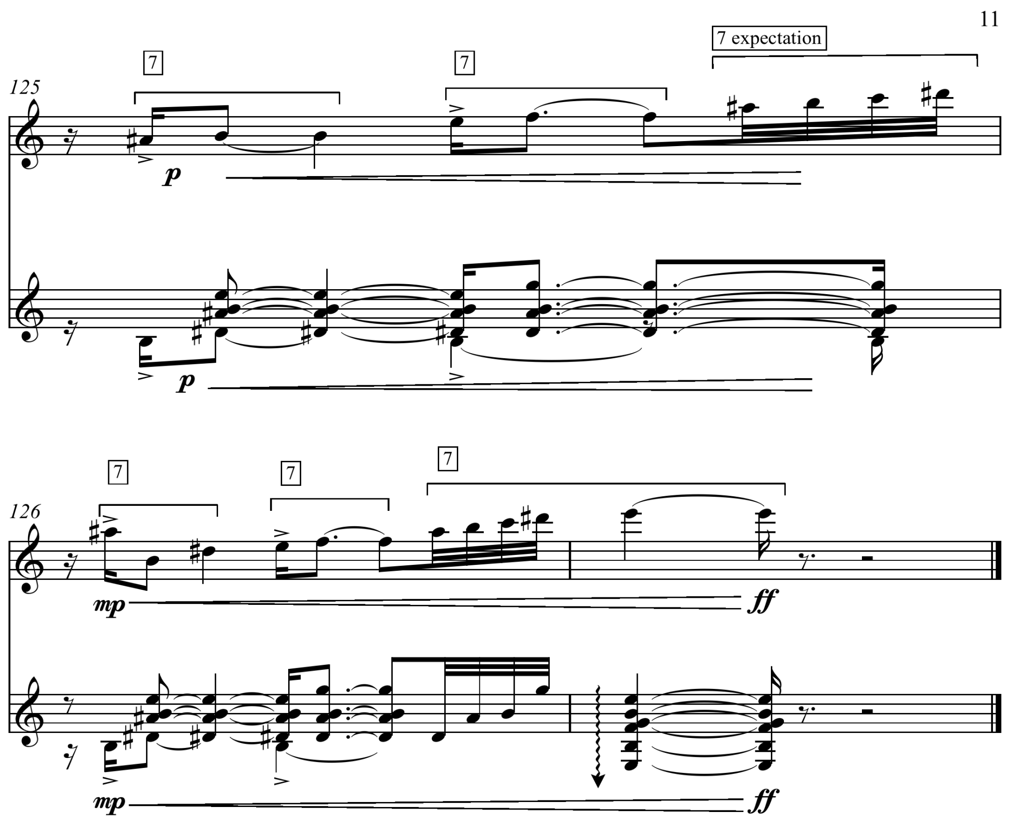


Figure 57b: Based on a *chakradhar tihai* or *nauhar tihai* of (7 + 7 + 7) x 3

Musical analysis makes assumptions about audience expectations. This is problematic in that the audience needs cross-cultural knowledge to understand the context and structure of a complex *tihai* like that in Figure 57. When a new composition is created using music from two different cultures, compositional concepts can become compromised or are misunderstood. My concern then became about how *mukthayams* would be perceived by a culturally new audience in the context of a cross-cultural composition. Becoming musically and culturally sensitive to this phenomenon is an ongoing informative process; how these ideas are used and whether they are transformed successfully into new musical ideas, genres and cultural meanings is another question.

Chapter 11: Analysis: Variations on Bhimpalasi for Flute and Guitar

11.1 Bhimpalasi Raga

Bhimpalasi is the most popular raga from the *dhanashri* group of ragas. These include *dhani*, *patdip* and *pilu*, all of which have variations of the pentatonic scale in ascent. The common feature with these ragas is they all omit *re* and *dha* in ascent and have a strong emphasis on *pa*. The *vadi* notes include *sa, ma* and *pa*, and ascending phrases often begin on *ni* (Bor, 2002, p. 40). There are many standard phrases that give *bhimpalasi* its character and these will be outlined in relation to where I have used them in *Variations on Bhimpalasi.* To give the true character of *bhimpalasi*, the ascent and descent must be played strictly when improvising or composing, although once a performer has mastered the ascent and descent structure, these rules are sometimes broken. The basic composition was given to me by one of my teachers, Samuel J. Dass, with whom I studied raga in Malaysia. This original raga conforms both to the basic *asthai*[9] and *antara*[10] compositional form and to *the arohi* and *avarohi* structure (Figure 58).

Ascent = Arohi S$\underline{G}$MP$\underline{N}$S Avarohi = Descent S$\underline{N}$DPM$\underline{G}$RS= Do, ti, la, sol, fa, mi, re, do.

Asthai

3 o + 2

| - - - P$\underline{N}$| D MP $\underline{G}$ M| P P P MP| $\underline{G}$ RR $\underline{N}$ P$\underline{N}$ |

3

|$\underline{G}$ R S |

Antara

3 o + 2

| - - - MP|$\underline{G}$ MM P NN|S S S P$\underline{N}$| $\underline{G}$ RR S $\underline{N}$S |

3

|$\underline{N}$ D P - |

Figure 58: The basic written compositional format of a raga used in Indian music. The raga is in *tintal* and conforms exactly to the *arohi* and *avarohi* structure of *bhimpalasi*. Lines under notes indicate pitch to be lowered by a semitone.

[9] The *asthai* is the primary theme and it is similar to the refrain in Western music. It is fixed and forms the basis for most North Indian instrumental and vocal performances.

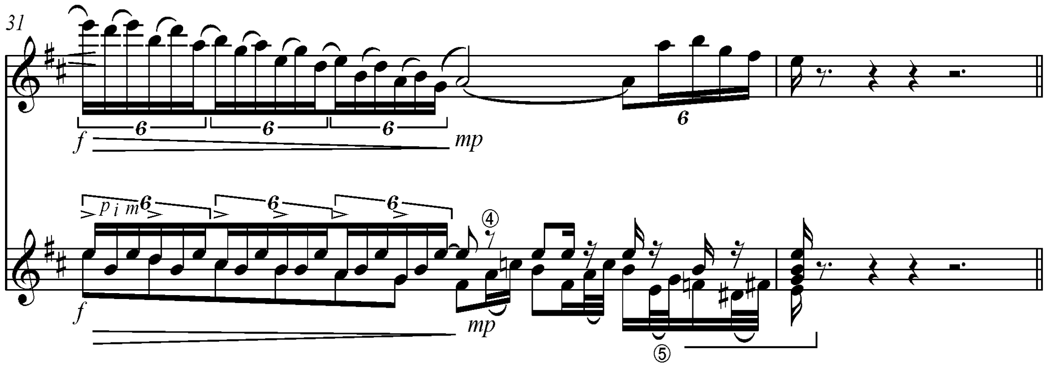
[10] The *antara* is the second section of a composition containing notes from the upper register.

The combining of Western harmonic compositional concepts with Indian linear rhythmic concepts made *Variations on Bhimpalasi* a difficult compositional exercise. Many of my compositional drafts were discarded because the combination of some Western and Indian concepts just did not work. Other concept combinations I had to really work through in order not to compromise either concept. However, I often had to compromise to find a new conceptual idea. For example, blending a baroque-type harmony, *korvais* and the limitations of particular ascent and descent patterns in *bhimpalasi* was a difficult combination of concepts (Variation 6). Using *bhimpalasi* and combining it with atonal harmony and keeping the character of the raga was also difficult, but easier than dealing with traditional Western harmony. Quick harmonic rhythm negatively affected the clarity of linear rhythms (a point I will discuss later). There are also many references to genres and styles in *Variations on Bhimpalasi;* these include renaissance lute music, baroque harmony, atonality and extended techniques. Underlying all these is the raga *bhimpalasi,* which I used as a structural reference point to hold the composition together. The real difficulty was keeping the balance and integrity of *bhimpalasi* in these different harmonic situations.

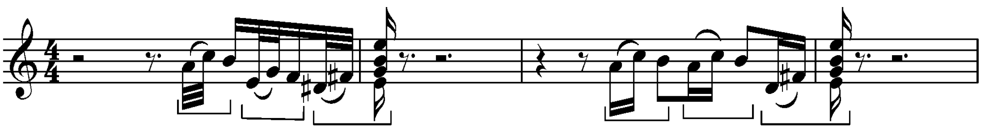
Variations on Bhimpalasi opens with an augmented *asthai* theme in the bass line of the guitar accompanied with open E and B treble strings functioning as drones in bars 1–11 (Figure 59). The theme is then repeated in the guitar's treble voice with an accompanying B drone string (the E string is not available because the melody is played on this string); the theme is then doubled by the flute with added ornamentation in bars 12–23 (Figure 59). The presence of the C and F natural in bars 15–19 would imply that the raga is no longer in *bhimpalasi*; however, the 'Ahobalas Treatise' (Bor p. 40) suggests that there was a type of *bhimpalasi* with natural *re* and *dha;* here, I draw on historical influences outlined by Bor (2002, p. 40). It is worth noting that the addition of these notes from a Western compositional perspective transforms the raga through a cycle of fifths from D major to C major. The addition of the natural *re* and *da* notes enabled me to continue the parallel and quartal harmony that I began in bars 12–14. The introduction is based on *alap and* the *asthai* theme, and is played in the compositional style of Luis de Milan (born 1536), where melody notes are often accompanied by block chords with minimal and spatial accompaniment patterns. The *alap* ends with an F Lydian chord, or alternatively in the *bhimpalasi* raga with natural *re* and *dha*. Here, I should point out that using one cultural form of analysis is uninformative and inappropriate. Moreover, the musical parallels and differences in Western and Indian music can only be understood by looking through both Western and Indian analytical cultural lenses. Hence, I will be using both forms of analysis and cultural perspectives to highlight specific and important compositional features used in *Variations on Bhimpalasi.*

Figure 59: *Alap* introduction and theme in the chordal style of Luis de Milan with accompanying E and B guitar treble strings functioning as drones

At bar 31 (Figure 60), the *alap* introduction ends with what I call a double *mukthayam* A + B. This is a combination of the same *mukthayam* in its diminuted and original form, with the diminuted *mukthayam* beginning halfway through the original, which allows it to resolve on the *sam*. I have written out both the diminuted and original *mukthayams* A and B and bracketed their ternary structures.



Double mukthayam. A combination of A and B with added drones E and B in the guitar.



(A) Diminuted *mukthayam* B Original *mukthayam.*

Figure 60: A Double *mukthayam,* diminuted and original combined with added drone notes E and B.

The idea in (Figure 60) was to set up a *mukthayam* with a false resolution then resolve it through augmentation or diminution and combine the two *mukthayams* together. This idea has been taken from the concept of a sub *mora.* However the theme proper begins with the *antara*, which is very close to the original theme given to me by Samuel J. Dass. The determining factor of an *antara* is a recognisable theme and a clear tempo; this is set up with a metric modulation in bars 20–32 (Figure 61). I have used *nadai* more as a tool for development than the introduction of themes and tempo changes for entire variations (see Figure 72). In most of this composition where there is a tempo change for an extended period, metric modulation rather than *nadai* is used. The reason for this is that metric modulation is familiar territory for the Western musician and that playing extended *nadai* patterns causes them to lose their effectiveness the longer they are unresolved. They also do not always translate well into Western notation.

The flute in bars 19–30 (Figure 61) plays strict *bhimpalasi* and is doubled by the guitar's bass, except for where the D major scale is used freely in bars 30–32 (Figure 60). The guitar also uses strict *bhimpalasi* in the treble voice in bars 1–10 and bass voice in bars 15–18 (Figure 59). However, the theme is often hidden by block chords combined with drone strings. The flute ends the *antara* by playing a very characteristic *bhimpalasi* phrase, that is, *ma, pa, ga, re* and *sa* at the end of bar 31 (Figure 60). Unless familiar with the *bhimpalasi* raga, a Western listener will not recognise the characteristic phrases.

Figure 61: The *antara* begins in a clear and recognisable tempo and is a very close approximation to the original *bhimpalasi* theme

11.2 Variation 1, Tisra Nadai

The original idea in Variation 1 was to use *tisra nadai* in all its variations that is, ¾, 1½, 3, 6, 9 and 12, and so on. I decided against fully exploring this idea as it would introduce excessive complexity too early and shorten the entirety of the composition, leaving little room for development. Consequently, Variation 1 is kept simple.

Variation 1 begins with the guitar's bass line in strict *bhimpalasi* playing the notes of the original theme in crotchets and using the E and B treble strings as a triplet drone accompaniment in bars 33–40. The flute plays freely around the guitar and it is only at bar 41 (Figure 62) with the introduction of a flat *re* that the guitar starts to divert melodically away from the original *bhimpalasi* theme. This is done by adding a new melodic line in parallel fifths to the guitar's *bhimpalasi* bass line at bar 42. Large intervals and chromatic notes in the flute not characteristic of the *bhimpalasi* structure also add to this diversion in bars 42–45 (Figure 62). At this point, the composition begins a battle between *bhimpalasi* and not *bhimpalasi.* The exploration of this idea allows a more flexible cross-cultural compositional process combining Hindustani, South Indian and Western compositional processes. For example, I counterpointed two ascending bhimpalasi ragas: the *arohi* (C#) *bhimpalasi* appears in the crotchet pulse of the flute, against the guitar, which is still in E *arohi bhimpalasi* at bar 42 (Figure 62; marked with arrows). At bar 43, the original *bhimpalasi* structure appears in the flute on the third note of each triplet, while the other notes outline B harmonic minor.

Figure 62: Original *bhimpalasi* theme embedded in the texture through ornamentation, chromaticism, transposition and augmentation combined with the introduction of new linear melodic material

The *bhimpalasi* structure is now disappearing and not featured as it was in the introduction. In both the flute and guitar, the intervallic outline is completely different from what is characteristic of *bhimpalasi* and is more a free use of the E Dorian scale in bars 46–51 (Figure 63). The compositional structure now starts emphasising rhythmic cadences rather than *bhimpalasi*. For example, at bars 47–

48 there are several *tihais* resolving into each other: bar 46 (1 x 3) quavers, bar 47 (3 x 3) crotchets, bar 48 (3 x 2) minims followed by a (3 x 6) semiquaver triplet *mukthayam* resolving into bar 50.

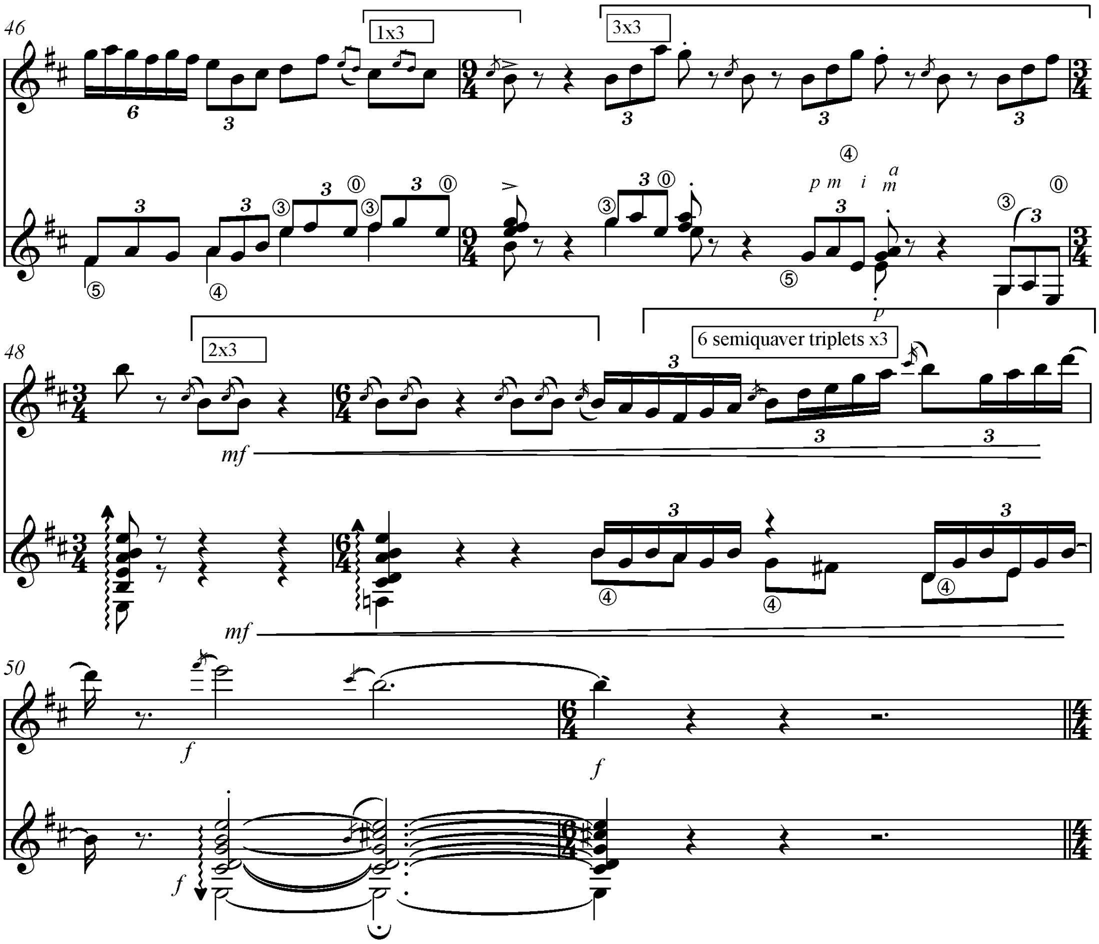


Figure 63: Successive *tihais* and *mukthayams* combined with new melodic material resolving into each other with little new musical material between them

11.3 Variation 2, Alap

Variation 2 makes references to *bhimpalasi* and the original *asthai* but is interspersed with harmony and intervals dissonant to *bhimpalasi* for dramatic effect. It is a textural interlude played at half the original tempo (crotchet = 54). It includes spacious chords, varied rhythms and performance instructions to play rhythmically free, giving an *alap* sensibility. For example, the flute uses *bhimpalasi* but in a more free and improvised way using a variety of extended techniques at the flute player's discretion. The guitar uses open string harmonics using the first three partials on each string, all of which are pitches within E *bhimpalasi.* There are no specific rhythmic cadential formulas used in this variation. However, right-hand guitar fingering patterns used in previous *mukthayams* are freely developed rhythmically and melodically. This technique of using *mukthayams* is a useful tool for guitarists wanting to freely develop improvisational accompaniment patterns using chords.

11.4 Variation 3, Jugalbandi

Variation 3 is a *jugalbandi* between the flute and guitar.[11] *Jugalbandi* usually happens between two or more soloists who compete musically. A *jugalbandi* can only be called *jugalbandi* if neither musician is clearly the soloist or the accompanist (Bagchee, 1998, p. 329). In this *jugalbandi*, the guitar starts with a *jhala* pattern, using the B and E treble strings as drones and an accented *ni* on the first beat of each bar (Figure 64, bar 89). This repetitive motive appears throughout the variation as a resting point between the *jugalbandi* sections.

The first *mukthayam* in *tisra nadai* begins on the flute, it is a *mukthayam* of (12 x 3) with each twelve-note phrase divided into (4 x 3) (Figure 64a, bars 89–90). It functions as a *chakradhar tihai* of (4 x 3) x 3 because each four-semiquaver motive is repeated exactly nine times. The guitar initially resists being influenced by the flute's *mukthayam* but is eventually pulled towards its rhythmic intensity by joining in with semiquaver triplets in bar 90. This is followed by another similar *mukthayam* of (6 x 3) from the *ta di gi na tom* family, but this time in *chatusra nadai* at bar 95 (Figure 64b).

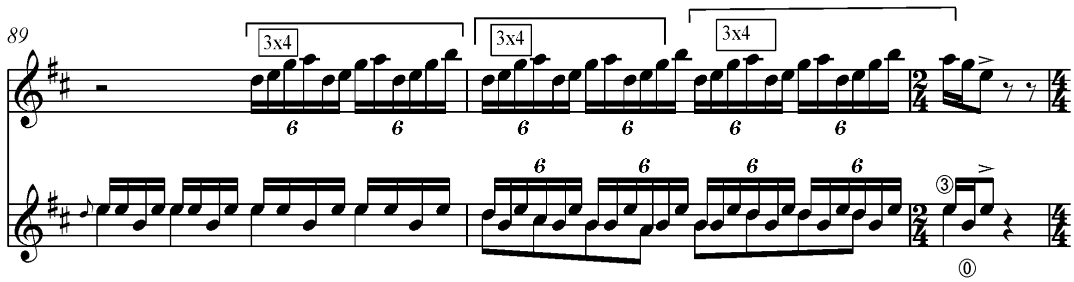


Figure 64a: A *Mukthayam* of 12 x 3 with each 12-note phrase being divided into (4 x 3) x 3 and functioning in a similar way to a *chakradhar tihai*

[11] In Hindustani music, *jugalbandi* translates as duel. These two *mukthayams* (Figures 64a and 64b) are related, in that the numbers used ($1^{1/2}$, 3, 6, and 12 and so on) are an extension of the same rhythmic idea.

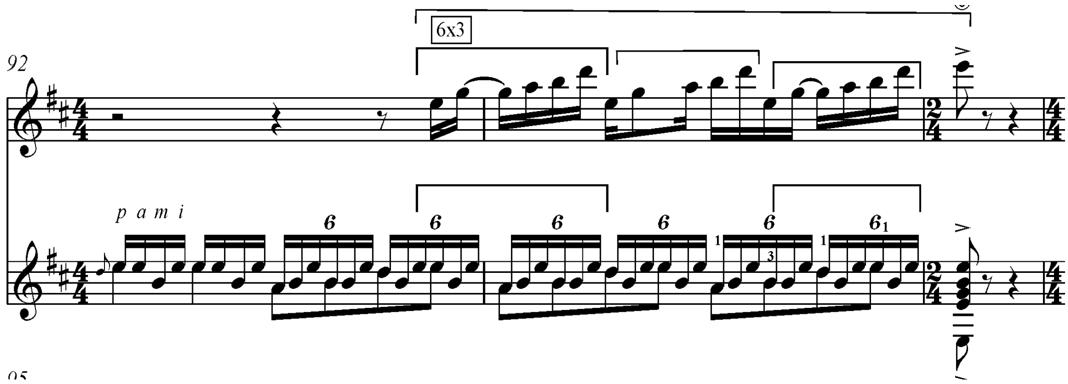


Figure 64b: ***Mukthayam*** **of 6 x 3 taken from the** ***ta di gi na tom*** **family of rhythms**

In bars 95–100 (Figure 65) the guitar and flute play a *gopucca jugalbandi* in strict *bhimpalasi*, discounting the E and B drone notes in the guitar. Table 12 outlines the *gopucca jugalbandi* numerically, with each number representing a crotchet beat. These phrases get progressively smaller starting with alternate one-bar phrases and ending with alternate quaver phrases. In traditional *jugalbandi*, there is generally no accompaniment from either instrumentalist. However, I chose for the guitar to play the opening *jhala p*attern to accompany the flute, which also gets progressively shorter as the *jugalbandi* progresses (see Table 12).

In North Indian music, *jugalbandi* is a call and response of unison phrases. I chose not to do this, as the flute lines would be too difficult to play on the classical guitar. Instead, I chose to use idiosyncratic guitar phrases that rhythmically imitate the flute and could also be played at a very fast tempo to match the flute's *nadai* patterns.

Table 12: Mathematical structure of ***gopucca jugalbandi***

Guitar	**Flute**	**Bars**	***Jhala*** **Pattern**
4 beats	4 beats	95–96	Bar 96
2 beats	2 beats	97	Bar 97.5
2 beats	2 beats	98	Bar 98.5
1 beat	1 beat	99	
1 beat	1 beat		Bar 99, beat 2
1 beat	1 beat		
1 beat	1 beat		Bar 99, beat 4
.5 beat	.5 beat	100	Bar 100
.5 beat	.5 beat		
.5 beat	.5 beat		
.5 beat	.5 beat		

Figure 65: This *gopucca jugalbandi* alternates progressively shorter phrases between instruments and includes an accompaniment *jhala* pattern on the guitar. Bar 100 is the last phrase of the *gopucca jugalbandi;* here, both instruments alternate phrases the length of a quaver

At bar 101 (Figure 66), a long *gopucca yati* begins with each player using a variety of *chatusra nadai* patterns. Although the *gopucca yati* starts to expand into patterns of four semiquavers at bar 107, it is not enough to convincingly qualify as a *damaru*[12] *yati.* The guitar and flute both phrase according to the structure of the

[12] *Damaru yati* increase in length up to a point then decrease in length.

gopucca yati but use different *chatusra nadai* patterns, which are beamed numerically with each successive phrase (Figure 66). This is so the players can see and hear the sequenced diminuted rhythmic patterns. If these phrases were beamed according to harmonic rhythm or crotchet beats, the *gopucca yati* could sound quite different when performed. With conventional Western beaming these rhythmic patterns are much harder to decipher: the player can see where the beat is but the feeling and visualisation of the *gopucca yati* is lost. (There is always a compromise between linear rhythms, harmonic rhythm and clarity of pulse.) The patterns used in the guitar are mainly right-hand arpeggio patterns functioning much like the right hand of a *mrdangam* player. Here, the guitarist's fingers correspond to a particular string, just like the *mrdangist's* fingers correspond to a particular drum sound (Figure 66, bars 101–108). The *gopucca yati* ends one quaver before the *sam* (bar 108). Rafael Reina makes a similar point about beaming and bar lines:

> After years of composing using traditional western notation—where the phrase is always 'divided' according to an imaginary 'beat line' notation, and experimentation with all sorts if accents, double accents, slurs dotted slurs etc.— I realised that this traditional notation could never convey to the performer the feeling of tisra while being in khanda). Rather, what I obtained from the performer was the feeling of the gati with a dynamic accent on specific notes, but failing to be felt as a cyclic accent that should provide the feeling of being in a different gati and tempo (Reina, 2015, p. 46).

Figure 66: *Gopucca yati* using a variety of *nadai* and beamed according to its numerical structure and ending one *aksara* before *sam*. (7 x 4) + (6 x 6) + (5 x 4) + (4 x 4) + (3 x 4) + (4 x 4) + (2 x 4) + (1 x 4)

11.5 Variation 4, Dissonance

Variation 4 is the most dissonant variation in comparison with the other variations. The *asthai* is referenced rhythmically and melodically but is often obscured by syncopation, atonalism and harmonic density. The *asthai* is now compositionally embedded and fractured throughout the variation, functioning as a subconscious aural reference underlying the formal structure.

The variation begins with the ornamented *pa, da, ni* motive on the flute and continues referencing every second or third note of the *asthai* (Figure 67, bars 111–115). The *pa, da, ni* motive is also played in various *nadai* patterns and melodic sequences throughout the variation but cannot be specifically identified as *bhimpalasi* because of its textural surroundings. For example, the guitar enters with the original *asthai* harmonised in parallel minor sevenths at bar 113 and then in parallel major sevenths at bar 118. The flute also references the opening *asthai* phrase rhythmically but less so melodically at bars 115–117. At bar 118, the guitar's parallel harmony continues with an added B drone, which the listener would not aurally recognise as a drone because it continues to be structurally embedded within a harmonically dissonant and denser texture.

Figure 67: The flute references the *asthai* and the *pa, da, ni* motive by interspersing it with notes dissonant to *bhimpalasi*. The guitar plays the *asthai* harmonised in parallel minor and major 7ths with an added B drone functioning as a harmonic dissonance in bars 118–125

As the variation continues, the guitar and flute make less and less reference to the original *asthai* and *bhimpalasi* raga. For example, the *ni,* in the *pa, da, ni* motive is displaced in the guitar's upper voice by a semitone (D to D#) and is rhythmically augmented (Figure 68, bar 122). The guitar starts using block parallel major chords using the intervals of a perfect fifth and a compound major third above the root. Each chord includes the added open B string, which functions as a chromatic dissonance in each chord at bars 122–123. The chords also become progressively more arpeggiated, harmonically denser and linear as more complex *nadai* patterns are introduced. In bar 124, the guitar's vertical harmony gives way to arpeggiated linear melodies based on the same vertical chordal clusters. The interspersed B drones within the chords when arpeggiated also add a peculiar angular melodic counterpoint to the flute. This is an effective alternative to the standard guitar accompaniment patterns. Both parts are now relatively atonal, melodically independent and have a tenuous relationship to the original *asthai* and *bhimpalasi* raga. This added complexity makes the *asthai* and *bhimpalasi* raga difficult to recognise but functional as an underlying compositional device (Figure 68, bars 122–126).

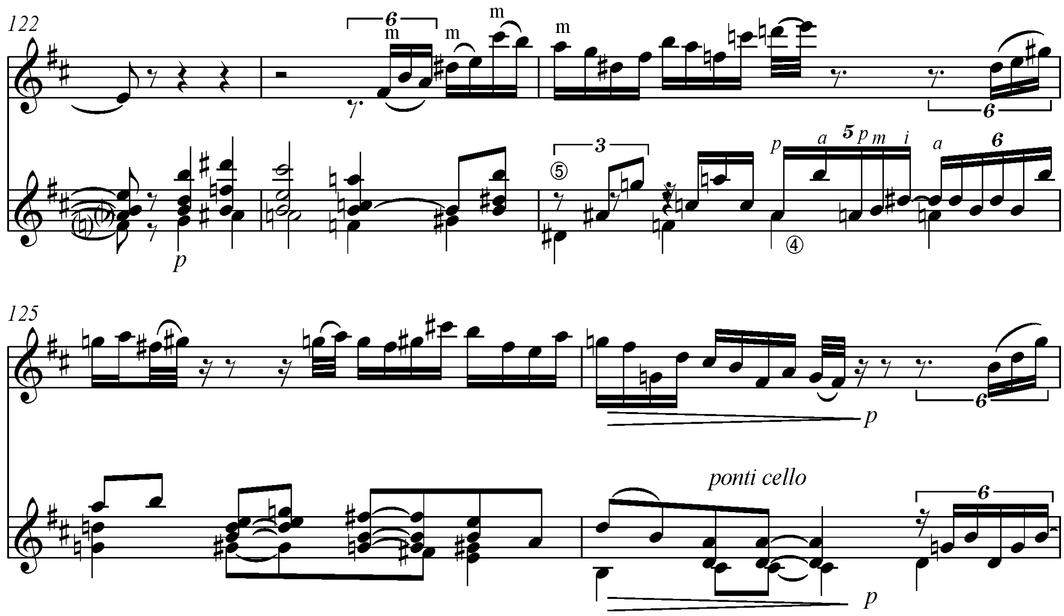


Figure 68: The guitar plays the theme in the top voice using parallel major chords employing the intervals of a perfect 5th and compound major 3rd. The drone B is used in each chord regardless of dissonance, keeping a tenuous reference to *bhimpalasi.* The flute plays atonally and rhythmically free with both parts becoming more harmonically and rhythmically independent

In Figure 69, at bars 132–133, the *asthai* is buried melodically within the inner voices of the guitar's harmony (marked with arrows). The flute is melodically free and intersperses a rhythmically diminuted *pa, ni, da* motive between its sequences.

The melodic style here is of a typically Brazilian choro characterised by flowing semiquavers, an anacrusis of three sixteenth notes and simple traditional European harmony.

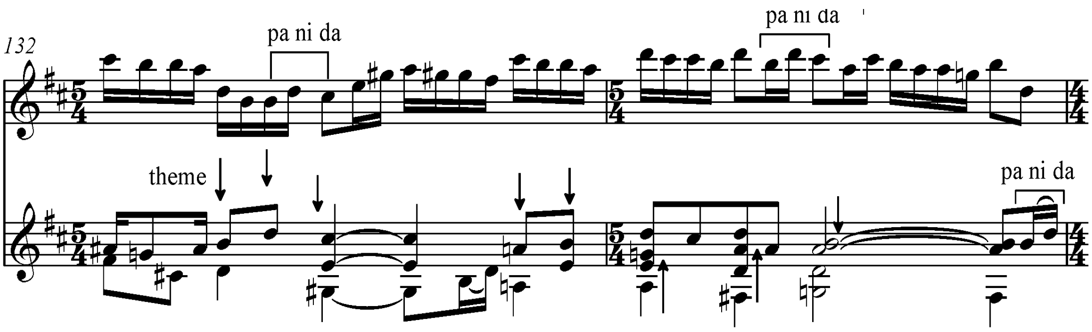


Figure 69: *Bhimpalasi* melody buried in the upper and middle voices of the guitar, the *pa, ni, da* motive diminuted and the flute in the style of choro

11.6 Variation 5, Metric Modulation and Nadai

Variation 5 starts with a metric modulation, increasing the speed by one third of the previous tempo and develops the *pa, ni, da* motive melodically in the E Dorian mode (Figure 70) bars 137–140. I refer to the scale as E Dorian because it does not follow the *bhimpalasi* structure, although both scales have the same pitches. The *pa, ni, da* motive is transformed into a variety of *tisra* and *chatusra*[13] *nadai* patterns using tonal sequences.

Figure 70: The *pa, ni, da* motive developed sequentially in E Dorian in both the guitar and flute parts

The *pa, ni, da motive* continues in the flute in both *tisra* and *chatusra nadai* with the guitar playing a series of E Dorian sequences in multiple *nadai* patterns (Figure 71, letters A, B, C, and D). This E Dorian scale is very idiosyncratic to the guitar and allows the guitarist a greater technical flexibility than most other keys. The guitar's

[13] *Tisra* and *chatusra* are pulse divisions of three and four respectively. Multiple divisions of these *nadai* are admissible for example 3 includes 1½ ,6 or 12 etc.

open strings and harmonics in the first three partials combined with fretted notes makes fast melodic passages easy to play. This is very important because if a melodic line is to be manipulated and played in a variety of different *nadai* patterns, it needs to be technically easy. The original guitar pattern and its variations are outlined in Figure 71.

There are two ways in which I like to develop a *nadai* pattern. The first is to find where in the bar the new *nadai* pattern needs to begin so that the last note of the phrase lands on the *sam* (see Appendix D, p. 236). The other is to alter the time signature so the new *nadai* pattern fits within the bar structure (see C and D in Figure 71). I have used both these ideas in Variation 5; I have also varied some phrases to fit within the bar structure by repeating or subtracting notes. For example, D adds repeated notes to extend the bar, which is still shorter than the original because of the speed. These *nadai* patterns are based on *one* sequential idea and played in different *nadai* patterns and always with the *sam* in mind. During the guitar's *nadai* patterns, the flute rhythmically and sequentially develops the *pa, ni, da* motive from the guitar's harmony and plays it against the guitar's *nadai* pattern bar (Figure 71, bar 148). This idea continues until the guitar and flute play a rhythmic unison passage at bar 151, which brings the composition back to the original tempo at bar 152, starting with a metric modulation.

Figure 71: *Nadai* patterns developed from one phrase and resolved on the *sam* by either adding or subtracting notes, or replacing the phrase and changing the time signature. While *nadai* is developed in the guitar, the flute develops the *pa, ni, da* motive melodically from the guitar's harmony in both *tisra* and *chatusra nadai,* bars 148–149

At bar 155 (Figure 73), I have used the *srotovaha yati* concept and demonstrated in different *nadai* (Figure 72). Here, each phrase gets longer and has a fractal aesthetic relationship to its proceeding phrase. I will outline some of the different ways I have used this *srotovaha yati* and how this idea can be used in composition and improvisation in general.

Ta ki ta tam .
Ta ki ta tam .
Ta ki ta 5 + 5 + 3 = 13

Ta ka di na tam.
Ta ka di na tam.
Ta ka di na 6 + 6 + 4 = 16

Ta di gi na tom tam .
Ta di gi na tom tam .
Ta di gi na tom (tam) (sam7 + 7 + 5 + (1sam) = 20
(Sam) = 48

Figure 72: *Srotovaha yati* in *adi tala* outlined in both Indian and Western notation. It is in 8/4 time: played in crotchets it will take 6 cycles to complete, in quavers 3 cycles, in semiquavers 1.5 cycles, in triplets 2 cycles and in semiquaver triplets 1 cycle

The aesthetic and geometric design of this *srotovaha yati* is what makes it musically and structurally interesting. It divides into three parts with each section having a binary structure. The structure of each section is increased numerically by three *aksaras,* so each number in the new section increases by one *aksara* (Figure 72). It is the fractal simplicity that makes *srotovaha yati* patterns like this aesthetically pleasing and easy to remember. When hearing phrases like this for the first time, we might not recognise the numerical structure but the patterning and syntax has a dynamic effect on our psychoacoustic understanding of rhythm. Long diminishing or expanding rhythmic patterns against a consistent pulse keep our attention and are excellent compositional tools for development, either in improvisation or classical composition. As long as *srotovaha yati* patterns keep developing in rhythmic intensity against the pulse they will always be interesting to listen to. Moreover, this interest is based on the fractal arrangement of their numbers and the increasing syncopations against the pulse.

At bar 155 (Figure 73), I manipulated the same *srotovaha yati* outlined in Figure 72 by using a different time signature for each numerical grouping. This works effectively; the rhythms are easy to play but it does not offer the sophisticated syncopation of the original. This is because it is not played against a consistent pulse and has become a group of individual phrases each with its own pulse and rhythm. In some harmonic circumstances, it is useful to re-write a *srotovaha yati* so that harmony and rhythm form a unit. Although useful in this context, it does not offer the performer the same challenging syncopations of the original and indeed this is not the function of a *srotovaha yati.* The question to ask is, why make it more complicated? Because playing these rhythms against a consistent pulse is generally a more satisfying bodily and intellectual experience. There are circumstances where both approaches are useful, but the determining factor in this question is the use of harmony. In Figure 73, the rhythm, harmony and time signatures form a one-dimensional rhythmic unit. However, in Figure 74, I used the identical *srotovaha yati* pattern in *tisra nadai* but this time against a consistent pulse. I felt a consistent pulse makes it more exiting to play because the rhythms are now in conflict with the pulse. In Figure 73, there is no real conflict with the pulse. Of course, both approaches are valid and contextual. However, my personal preference is to play *srotovaha yati* patterns regardless of *nadai*, against a consistent pulse, because it satisfies at a fundamental intellectual level the rhythm–pulse conflict. Learning *srotovaha yati* patterns in *konokol* are also useful for learning complicated syncopations and then applying them to different *nadai* and linear melodies in improvisation. For composition, unfortunately most software programs do not allow multiple time signatures simultaneously: this would allow the aforementioned concepts to work together on different compositional, rhythmic and harmonic levels.

Figure 73: A Simplified version of a *srotovaha yati* pattern transformed into Western notation. See also figures 72 and 73 for the same *srotovaha yati* in *tisra nadai*

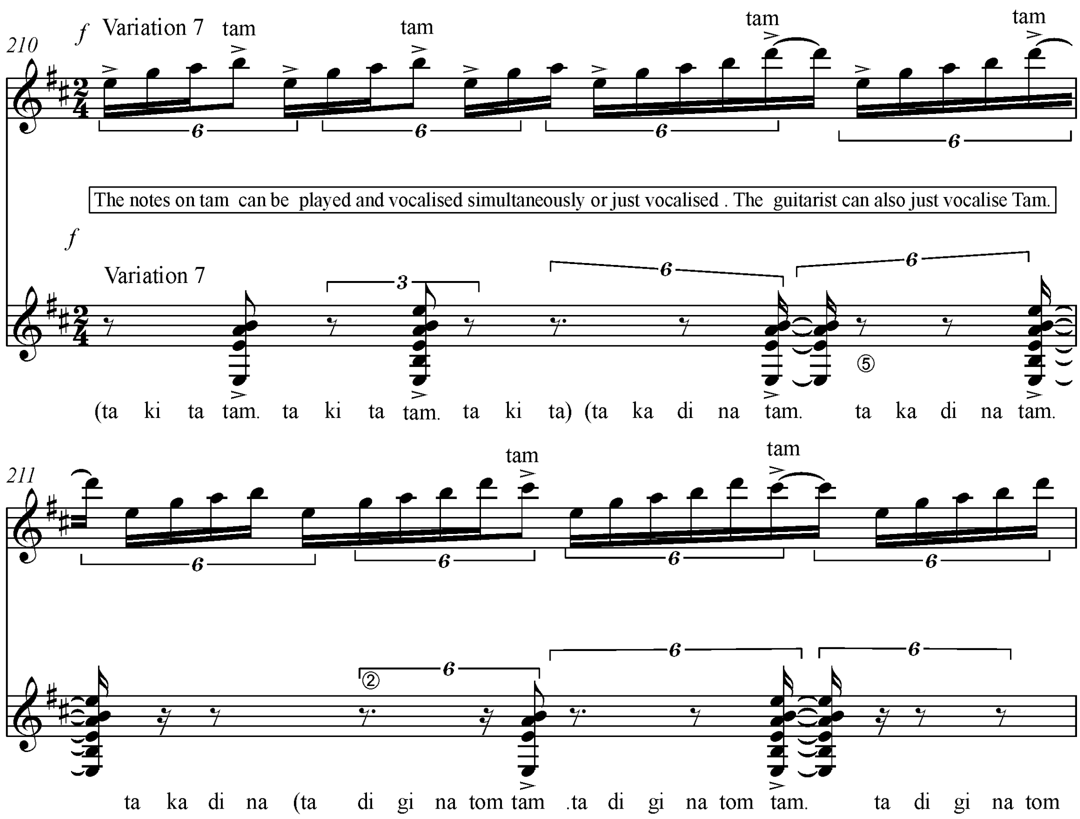


Figure 74: The same *srotovaha yati* pattern as shown in figures 73 and 72, played against a consistent pulse in *tisra nadai*

The implication for improvisation using rhythmic linear patterns that I deduced from this *srotovaha yati* is that one phrase or pattern can be used in many different circumstances. In jazz, the focus is primarily on the use of harmony and its substitutions; similarly, Indian music focuses on how to use rhythmic phrases in different situations. For example, a simple *tihai* in c*hatusra nadai* built on 3 + 3 + 3 can be used very effectively in different time signatures, it is just a matter of knowing where to start and finish. All c*hatusra nadai tihai* patterns of 3 + 3 + 3 in the basic three speeds will start in 4/4 time on beats 1, 3 or 4. This is useful knowledge for cadential formulas, but is also useful for phrasing and improvisation in general. An economical way to improvise is to know several *tihai* phrases well in various *nadai* and to know where to start and finish them in relation to the *sam*. In the case of this *srotovaha yati*, its *nadai* variations only limit the amount of cycles it takes to complete. This knowledge allows the extension of a single rhythmic idea to be used in a myriad of different situations (Figure 72).

11.7 Variation 6, a Baroque Damaru Yati

Variation 6 involved two disparate concepts: a baroque-type harmonic rhythm and long *gopucca* and *srotovaha yati* patterns. These concepts can be blended, but from my experimentation it is difficult to keep the integrity of both concepts, especially when one of the concepts becomes complicated. For example, complex traditional harmony and fast harmonic rhythm make linear melodic rhythms less identifiable. To retain the identity of a melodic linear rhythm as it becomes more complex, the speed of harmonic rhythm must be slower or at the same speed as the rhythms used. In this variation, the melodic linear rhythms are not clearly discernible because they are beamed according to pulse and harmony and not by their mathematical relationships. Here, I consider the rhythm to be subservient to the melodic contour, harmony and pulse because the *srotovaha yati* is not easily identifiable either to the performer or audience. A linear rhythm can still be complex, but when combined with harmony, linear rhythms are not easily mathematically recognisable. Instead, the Western audience and performer start listening to the harmonic pulse rather than the mathematics of the rhythms. A question asked by some of the performers of this composition was: "Do I just play the rhythms or play them against the pulse?" Because the concept of harmony does not exist in Indian music, structure, musical thinking and form are often entirely mathematically based. This is a way of thinking in some respects and is a choice that redefines cultural practices. Thinking of music as harmonically and mathematically independent entities empowers the musician to think outside of his or her musical cultural practices.

Variation 6 begins with the *pa, da, ni* motive in the flute accompanied by the guitar. The guitar here uses chordal arpeggios in *tisra nadai* in the harmonic rhythm of a crotchet. The flute plays two short *tihai* phrases in bars 166–168 and another in bar 170. However, these are part of the compositional fabric rather than important cadences and are more to set up an extended rhythmic pattern beginning at bars 172–181 (Figure 75). In this section, the flute plays an extended *damaru yati*.[14] Although it does not have a completely symmetrical structure except for the phrases that add up to 30 and 27 at the beginning and end (see Figure 75), the

[14] *Damaru yati* is a geometric shape in the form of an hourglass. It consists of decreasing lengths up to a point, then increasing lengths and is a combination of *gopucca* and *srotovaha yatis.*

structure as a whole functions as a *damaru yati* because of its incremental diminutive and additive structure. The very beginning phrase at bar 172 is 8 + (.1.) + 8 + (.1.) + 9 + (.1.). Theoretically, it should have been 8 + (.1.) + 8 + (.1.) + 8 + (.1.). However, I liked this variation, so I kept it. When complicated *yatis* become too symmetrical, this is often how they sound, so slight variations allow an aesthetic deviation from a too formulaic structure. The table below is a numeric representation of (Figure 75): without this information, it is extremely difficult to see these mathematical patterns in the score.

8 + (.1.) + 8 + (.1.) + 9 + (.1.) bar 172 (11 + 11 + 12)		
9. x 3	= 30	Bar173
8. x 3	= 27	Bar 175
7. x 3	= 21	Bar 176 grouped ([1 + 1.. + 3] + .) x 3
. . rests	= (2)	Bar 177
4. x 3	= 15	Bar 177
6 x 3	= 18	Bar 177–178
9 x 3	= 27	Bar 178–179
10 x 3	= 30	Bar 179–180

Figure 75: *Damaru yati* beamed according to harmonic rhythm, not by its mathematical structure (indicated by numbers in boxes). This makes it difficult to identify the *damaru yati* structure, yet it functions in a concealed and different way when combined with harmony

The rhythms in this *damaru yati* are beamed according to harmonic rhythm. This makes it difficult for the performer to identify any perceptible mathematical structure, because it is not immediately visible in the score. Western harmonic conventions generally dictate that phrases be performed according to harmonic rhythm and not linear mathematical groupings. If the performer learned these rhythms through the practice of *konokol* prior to the performance, the rhythms would immediately be apparent and the composition may be performed differently. It is arguable that if a rhythmic structure is not clearly perceptible aurally or visually represented in a score then it adds nothing compositionally or structurally. The difference between written and aural traditions interpreting the same music can be profoundly different, especially when interpretations come from a different cultural perspective. Cultural practices run deep. For example, cutting and pasting using Western musical software regroups linear rhythms according to harmonic rhythm, even when harmony is absent, which is not practical when dealing with Indian music. In performance, the cultural transference of musical ideas like this often becomes something *other* than the original intention. In fact, musical cross-cultural ideas can introduce unforeseen musical phenomena, which is an aspect not immediately recognisable to the performer or audience but which can become an important new creative process and practice.

It is enough for me that there is a narrative under way, regardless of the comprehension or understanding of the performer or audience. My argument here is that even when there is no structure at all in music (if that is possible), the mind has a will to invent one. The performer and audience come to a meaningful understanding in their own way. If you explore the work of the many philosophers that tackled the subjects of nothingness, emptiness, chaos, evolution and the pointlessness of existence, they all ironically had many things to say on these subjects. According to Meyer (1961 pp. 1–30), the will to invent or search for musical meaning will always exist somewhere on a continuum between referentialism and absolute abstraction, which in itself is another construct in the search for meaning or the lack of it. Moreover, the absence and flexibility of meaning in music is perhaps its greater power in thinking about it infinitely. *Naad* has a strong relationship with Indian music and is a *concept of sound* that reaches beyond music, the cultural and the self. *Naad* extends towards the infinite it fosters and develops insight into a personal relationship with sound that reflects on how we carry ourselves as human beings. This idea is culturally at odds with Meyer's because it is both an inward and outward reflection on sound.

After the *damaru yati* is completed, the *bhimpalasi* theme returns in the flute with the first note of each triplet outlining the main theme (Figure 75) at bar 181. The music continues with a mixture of free melodic material, the *pa, da, ni* motive in the flute and the guitar diminuting its triplet ostinato pattern. This breaks up the regularity of the previous section, allowing some new melodic development for the flute (Figure 76, bars 187–189). At bars 192–197, there is a short canonic section (refer to the score) that leads into a combination of *tihais* that end the variation bars of 198–204 (Figure 76). Many of these *tihais* do not land on the *sam* and function as both imitative melodic sequences and *tihais* alternating between the guitar and flute, so there is a playfulness of traditional Indian cadential forms here. For example, the guitar starts a *tihai* at bar 198 and the flute starts to resolve it but creates its own extended *tihai*. This dovetailing idea continues creating *tihais* of different lengths. It is not traditional to use *tihais* by distributing them between instruments and setting up false expectations. However, using a *tihai* in this way is a vehicle for a *jugalbandi*: a playful contest to control the *tihai* and resolve it. The last *tihai* of the variation is based on a unison *chakradhar tihai.* Here, each phrase is mathematically the same length but the flute uses a different *nadai* in each *tihai* repetition. The guitar accompanies this with a *chakradhar tihai* in bars 201–203. This is not traditionally how a *chakradhar tihai* is performed; however, I intuitively feel the number three is a deep and powerful structural metaphor that can have a psychological impact on the listener, even when modified. Three is a number buried deep in our culture, biology and psyche and relates to how we memorise patterns. On a basic level patterns begin with the number three, which makes three a powerful structural tool that relates to our patterning behaviours. Research on 'chunking' theory supports that the information that can be stored in the working memory is limited to a low-level number of items, usually three or four. The items can be increased, but only in relationship to these low-level groups. What affects the memorisation of increased items is number, time and spatial extent (Lourenco & Longo, 2011, pp. 225–237). *Konokol* patterns embrace this relationship, fully capitalising on working memory, where memory duration and the expansion of an idea mutually embrace through time.

Figure 76: Using *tihais* as a structural dovetailing device that links rhythmic cadences and phrases together and extends melodic sequences

11.8 Variation 7, Srotovaha Yati

Variation 7 begins with a *srotovaha yati* structured around the number three; its structure is as follows: (3 + 1. + 3 + 1. + 3) + (4 + 1. + 4 + 1. + 4) + (5 + 1. + 5 + 1. + 5). Inside the mathematics of this *srotovaha yati*, there are several relationships to the number three. For example, in each bracket there is a number repeated three times and there are six (1.) *aksaras,* which can also be divided into two groups of three. Each bracketed unit, totalling 13, 16 and 20 respectively, cannot be divided by three individually or in total (bar 210, Figure 74).

The musical material that follows this *srotovaha yati* is structured around the repetition of a three-note cell and is developed into longer phrases and *tihais* that dovetail into each other (Figure 77, bars 211–213). Dovetailing is a compositional tool used extensively in the construction of *korvais*. It is also a formula that assists in the memorisation of rhythmically complex mathematical patterns. I used this dovetailing strategy on a subconscious level, which became apparent once I started analysing my compositions. *Konokol* patterns, when repeated and learned with hand movements, become ingrained both *intellectually* and *physically*. Most Carnatic extended cadential formulas involve the linking of simple binary and ternary structures within a larger binary or ternary structure. The great advantage of this technique is that it allows working memory and complicated rhythmic patterning to work symbiotically.

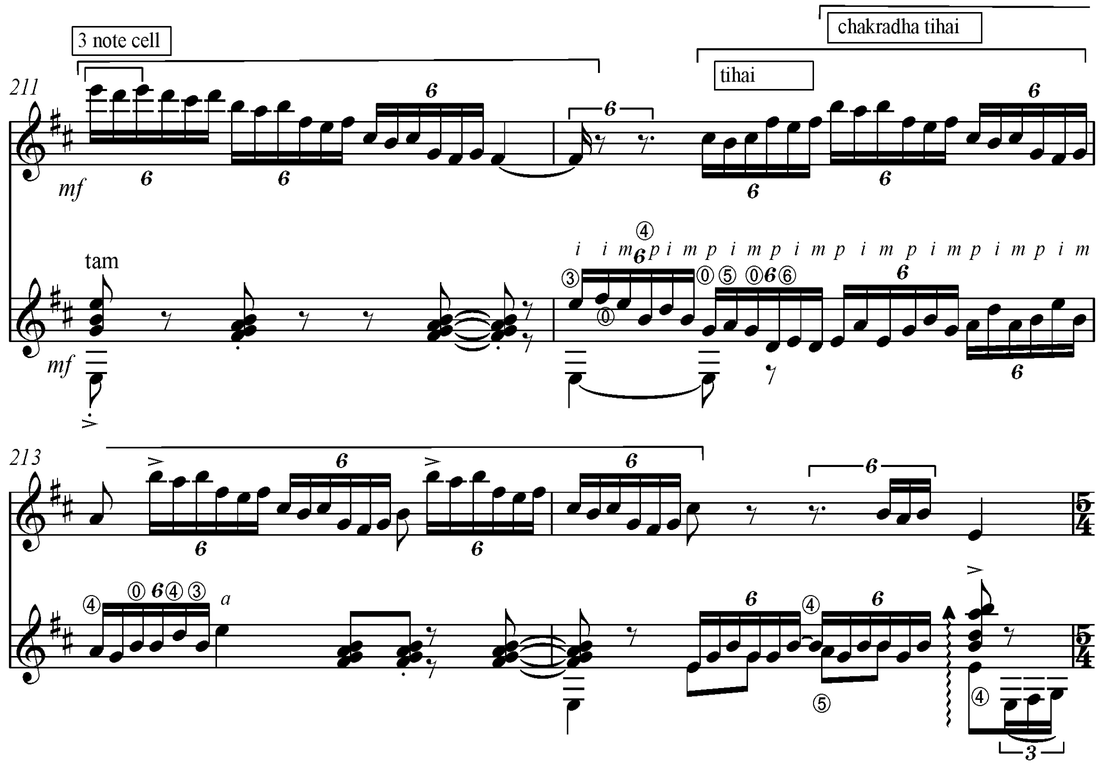


Figure 77: Two dovetailing *tihais* each maintaining their own structure and based on a three-note cell. The second *tihai* at bar 212 becomes a larger *chakradhar tihai*, resolving one *aksara* after the *sam* at bar 214

Figure 78 is an example where *mukthayams* are used as part of the composition and not as specific endings. The three-note cell, *tihais* and *mukthayams* all start to develop together unifying the overall compositional structure. For example, there are two *tihais* linked together by a quaver at bar 218. Both *tihais* are in *tisra nadai* and function as a springboard for sequentially developing the triplet semiquaver cell. In bar 221, I used a traditional Hindustani *tihai* in the flute part and chromatic harmony in the guitar part; I learned this *tihai* from my teacher Samuel J. Dass. The flute's last quaver in this *tihai* in bar 222 becomes the first note of an extended sequence using the three-note cell. Rhythmic cadences in Indian music are performed in melodic and rhythmic unison. Here, the guitar and flute use *tihais* independently, with different *yatis* and with different pitches.

The flute signals the recapitulation by introducing a simple *tihai,* the guitar accompanies the flute with an ascending E minor pentatonic scale and drone notes (Figure 78, bars 222–224). The flute then combines the opening *asthai* with a simple *tihai* at bar 223. At a fundamental level, the number three, *mukthayams* and *tihais* and their multiples are a structural unifying narrative that weaves these compositions and variations together.

Figure 78: *Tihais* and *mukthayams* becoming part of the compositional structure, functioning more as a compositional tool for both sequential development and rhythmic cadences

In the recapitulation, the texture and theme become sparser with less rhythmic complexity in both parts. For example, the flute plays a staccato accompaniment pattern with repeated notes from the *asthai.* The guitar quasi improvises idiosyncratic patterns outlining E pentatonic minor, bringing the focus back on the *bhimpalasi* (Figure 79, bars 228–237).

Figure 79: The recapitulation introduces a simpler texture and structure in both parts. The flute repeats notes from the *bhimpalasi* and the *asthai* with slight melodic variations. This functions as an accompaniment to the idiosyncratic ascending E minor pentatonic patterns on the guitar

Variations on Bhimpalasi ends with a *korvai* taken from *The Art of Konokol* by Trichy Sankaran (Sankaran, 2010, p. 62), demonstrated in Table 13 and Figure 80. It is in *tisra nadai misra chapu tala,* has 4 *avartas* and 28 *aksaras*. This means it takes up four cycles in a rhythmic cycle of seven and has a triple metre.

Traditionally, this *korvai* in Table 13 would be divided into *poorvanga* of 11 beats and *utharaanga* of 16 beats. This is because the *utharaanga* section is based entirely on *ta di gi na toms,* and could be arranged in various combinations of binary and ternary structures: it is therefore better thought of as one section (Nelson, 1991, p. 67). However, in this *korvai*, I chose to superimpose and manipulate the *gopucca* and *srotovaha yati* patterns in each ternary section using different speeds. The performer notes indicate the *korvai* can be played as written or in halftime or both, which allows the performer some interpretive freedom with the *korvai* structure. In the last ternary section, the flute breaks away from being in rhythmic unison with the guitar and plays the same *nadai* in a faster speed to increase rhythmic tension before landing on the *sam* (Figure 80, bar 240). In this composition, the *korvai* is in three sections but it is worth analysing the smaller internal structures that can be manipulated because this adds to a deeper structural understanding. This can be done best by practising *konokol* and *tala,* hearing the structure phonetically and seeing its geometric structure away from any Western score or instrument.

Table 13: *Korvai* in *misra chapu tala* using *tisra nada*i and based on rhythms from the *ta di gi na tom* family of rhythms. It demonstrates symmetry, *srotovaha* and *gopucca yati* and macro and micro ternary structures

Structure							Ternary Beats			Traditional	My Composition
		ta..	ta ki ta	Tom..			3	A	A	(A section)	*Srotovaha*
	ta..	di..	ta ki ta	Tom..			4		B	*Poorvanga*	11 beats
ta..	di..	ta..	ta ki ta	Tom..			5		C	11 beats	
			ta di.	gi na tom	ta	...	4	B	A	(B section)	Ternary
			ta di.	gi na tom			2		B	*Utharaanga*	Symmetry
			ta di.	gi na tom	ta	...	4		A	16 beats	10 beats
			ta di.	gi na tom			2	C	A	*gopucca*	Symmetry
			ta di.	gi na tom			2		A		6 beats
			ta di.	gi na tom			2		A		
			Sam		(Ta) 27 beats						

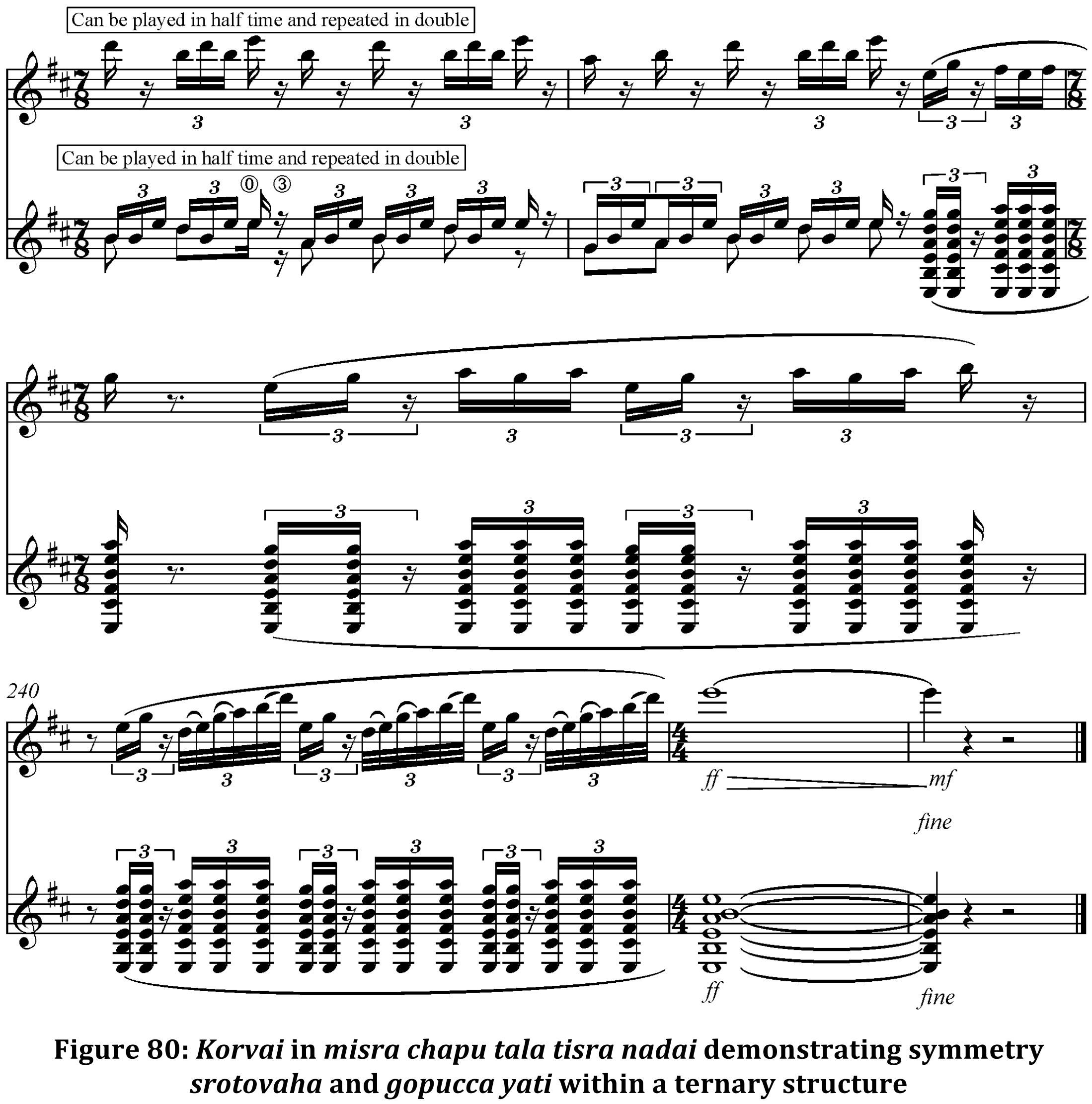


Figure 80: *Korvai* in *misra chapu tala tisra nadai* demonstrating symmetry *srotovaha* and *gopucca yati* within a ternary structure

Chapter 12: Discussion, Conclusion, Future Research

12.1 Discussion

I found the study of the *ta di gi na tom* family of rhythms revealed a conceptual breadth that goes beyond just rhythmic cadences. *Ta di gi na toms* can be used as a structural devise in through-composed music, linking together the whole of a composition by using related numbers and patterns. Using *ta di gi na toms* in different ways also provided a contribution to how I and other musicians can use these rhythmic concepts effectively in future work. However, the application of Carnatic rhythm for a melodic instrumentalist depends largely on the instrument and the player's technique, tastes and aesthetics.

The concepts throughout this dissertation build upon a conceptual framework of *konokol* rhythms*.* By examining *konoko*l through both my guitar improvisations and through-composed compositions. I found that Indian linear rhythmic concepts are suitable in particular harmonic contexts and adaptable to specific guitar techniques. My findings also revealed my unconscious physical and technical problems related to Western guitar techniques when combining harmonic rhythm and *mukthayams.* This resulted in me creating and re-examining methods of scoring rhythms and new guitar techniques to execute linear rhythms both harmonically and in a linear way: these techniques can be found in my compositions and the guitar exercises (see Appendix C).

In Chapter 5, I examined the different constructions of both *mukthayams* and *tihais* in relation to cyclic form. This highlighted frequently used rhythmic cadences involving numbers that gravitate towards each other, for example, the numbers 3 and 11 in Table 5. Interestingly, I found common *mukthayams* not to be numerically isolated from other phenomena. This became apparent by examining the mathematical aspects of the physical body and its relationship to mathematical patterns. For example, there are many recurring mathematical tropes like Fibonacci numbers and phi in culture, art and nature and it is no coincidence we use a 10-base number system and have 10 fingers (Benjamin, 2007, p. 10). The relationship of the numbers 11 and 3 is possibly another of these tropes. These mathematical relationships parallel many *mukthayam* and *tihai* calculations used in standard time signatures and *talas,* (see Table 5) 11+11+11*.* This cross-referencing identified some common mathematical tropes in culture and the more practical and common rhythmic cadences used in Indian music. It was through the arduous process of mapping many *mukthayam* permutations that a relationship between numbers was found to extend beyond rhythmic cadences to the body and other phenomena. Another finding was the structural relationship between *konokol* patterns and memory and the parallels in current research on working memory and chunking concepts in psychology. I found analysing and practising *konokol* patterns developed a deep intellectual rhythmic understanding. It also prompted me to enquire into mathematical patterns in nature, the mind, memory and mathematical patterns beyond the self.

Chapter 6 examined the cultural meanings, attitudes and differences between Indian and Western music and how these differences inform music in practice. Chapters 7, 8, 9, 10 and 11 were an analysis of my own scored compositions. This analysis examines the adaptability of linear rhythmic concepts and *mrdangam* patterns to Western harmony and the right-hand techniques of the classical guitar. These chapters also focus on the ways South Indian linear rhythmic concepts and Western harmonic concepts can stylistically coexist. Findings suggest both practical and new methodological approaches to combining harmony and linear rhythm but also limitations depending on the harmonic context. The important point taken from this research is that *konokol* is adaptable to almost any musical style and instrument: it is just a matter of application, although inventing new techniques might be necessary if one is to apply the full gamut of Carnatic rhythmic knowledge to a melodic instrument. However, the first step in applying *konokol* is to learn *konokol* itself.

The intellectual and physical aspects of rhythm raise the question of how we position ourselves on the rhythmic continuum between bodily experience and intellectual understanding. There are certain tempos within the rhythmic experience that have a strong relationship to our physical bodies. There are rhythmic limitations to what our bodies can act on and process. Complicated fast rhythms at some point cannot be experienced through the body: the mind is left processing them in a more cerebral way. For example, in Stockhausen's electronic music, rhythms are often manipulated and sped up until they become pitches and are no longer perceptible as rhythms (Chang, 2009). This division, despite the existence of a liminal point, eventually goes to the level of a frequency experience rather than a rhythmic experience. The other extreme is also possible in *vilambit khyal*: Clayton points out that it is remarkable that this music is performed in *tala* at all because it is very slow, rhythmically free, melismatic and appears to have no time (Clayton, 2008, p. 51). Since Descartes, the mind–body split has been fraught with dangerous assumptions; it is, however, fruitful to explore how we feel rhythm in relation to the mind and body. For example, rhythmic frequencies are still experienced through the body but not in a musically meaningful and transcribable way. For example, you cannot transcribe a frequency rhythmically or repeat it in *konokol*, although some tempos and rhythms in Carnatic music almost get to this point. My undergraduate music training instilled in my philosophy that if you *cannot* repeat a phrase that you have heard, it is generally accepted that you are not hearing or understanding it. *Konokol*, however, is a tool that enables the body and mind to connect rhythmically through *kriya*, vocal syllables and mathematics. In rhythmically free music, complicated rhythms are often intellectually understood after they have been played or transcribed. This is because they are not often predetermined. The question to ask is how much are these types of rhythm experienced through the body when the pulse and patterns are individual and less externally imposed or learned, and how do you measure their rhythmic educational value? The subject is too complicated to elucidate here, but there is a case to argue that many free musical styles developed from both not having a *comprehensive educational rhythmic system* and having a continued focus on harmony over rhythm. Ironically, the restrictions of *konokol*, pulse, *tala* and hand gestures combined, facilitate rhythmic and artistic freedom in body and mind. It is an exploration of mathematical infinity limited only by the finite mind and body. The oeuvre of rhythmic knowledge in Carnatic music is huge, well established and passed on from guru to student in a very structured, orderly and pragmatic way, from simple through to complicated mathematical structures. Historically, jazz improvisation knowledge and practice has been acquired through informal cultural practices and has only been recognised as a legitimised formal music practice since it was institutionalised (Berliner, 1994 pp. 22–30). However, by necessity, jazz improvisation before it was institutionalised was very open to assimilate other musical influences. In Carnatic music, however, the rhythmic learning process was achieved between guru and student and through a very long, rigorous and methodical pedagogy based on understanding rhythm through mathematical sequences. The student had to learn these rhythmic sequences, permutations and variations deep within the body and mind, continually extending on pre-existing forms and structures—otherwise, playing Carnatic music was not possible. The adoption of both this educational process in a class situation and a knowledge of the variety of rhythms in Carnatic music would be a great asset in Western music education, mainly because *konokol* can be taught and mathematically isolated from the music itself.

I would argue further that some of the rhythms of free, aleatoric and arhythmic music are not remembered and felt in the physical body in the same way as they are in the physical body of a skilled *konokol* practitioner. Here, I refer to an interview I conducted with guitarist John McLaughlin in which we discussed rhythm, sexuality and music. To *reductio ad absurdum,* imagine running or having sex to music that cannot be felt as a bodily rhythm. The event would become more about the music *or* the sexual or running experience, rather than about the music, mind, body and rhythm becoming complete or one experience. Arrhythmic music for most people is probably not the first choice to have sex or jog to. Moreover, there are definitely certain rhythmic patterns and tempos that are in sympathy with our biological rhythms, regardless of culture. John McLaughlin hinted at this topic in our discussion of Western music and rhythm: "The body at its fundamental level is a sexual rhythm and Western music has historically wanted nothing to do with rhythm and sexuality" (paraphrased). The practice of *konokol* with hand movements is perhaps a way around this historical aversion to memory, body and rhythm. The important point here is that certain musical practices outside the canon of Western classical music thoroughly embraced its relationship to sexuality, rhythm and the body. This alone is an important factor in the development of rhythm within a culture. Historically, Western art musicological studies on sexuality and music have similarly focused on, for instance, class, social and gender construction, ideology, homosexuality and power rather than sex and rhythm. For example, the book *Musicology and Difference*, edited by A. Solie (1993), focuses on gender with little mention of sex and rhythm. Arguably then, the inclusion or exclusion of biology, number, sex and rhythm play their part in the discursive formations of musical structures and are equally worth researching in relation to sexuality and the development of rhythm in musical cultures.

12.2 Conclusion

Konokol/solkattu is a well-established academic discipline and a very effective pedagogical practice. *Konokol's* mathematical foundation allows universality in its application for teaching rhythm. Apart from this, I found *konokol* to be useful conceptually and structurally in composition and improvisation. *Konokol* is a holistic practice that combines both the limits of the intellect and rhythms that can be felt in the body through hand gestures and vocalisations: a practice absent in Western music. As outlined in my compositions, there are many different ways that *konokol* can be used with harmony, despite there being a conflict between harmony and linear rhythm. This conflict is systemic and appears in my written compositions; here, beaming, harmony and linear rhythms have to be written in a variety of ways to accommodate musical differences. From my research, I found that cultural differences and current research often limit the study of *konokol* to an anthropological object. Moreover, as a rhythmic academic discipline, *konokol* is restricted to a handful of Western music institutions. It is perhaps also this harmonic and linear rhythmic conflict that limits the assimilation of *konokol* as a pedagogical practice in Western music institutions.

My research primarily involved the marrying of Carnatic rhythms and Western music; this involved simultaneously balancing three concepts. These included: the length and complexity of a rhythmic calculation, harmonic rhythm and harmonic dissonance.

I found the length and complexity of Carnatic linear rhythms no obstacle when applied to the Western modal system, primarily because the Carnatic system is also modal. The barline in my compositions is not always necessary but functions as a convenient reference point for the Western performer, for example, when I beamed the groupings of a complex *gopuccha yati* the performer could recognise the rhythmic groupings. However, what did suffer was the recognition of pulse and bar line (see Figure 66). In the example shown in Figure 66, I found if I used Western beaming according to pulse it disturbed the rhythmic flow of this *gopuccha yati*. Moreover, a Western performer would start accenting the crotchet pulse in this context. As a composer, I felt that if I wanted the audience to hear a grouping of 10 notes I had to disregard beaming according to pulse and bar line and beam according to linear rhythm. Reina makes many of the same conclusions (Reina, 2016, p. 46).

When using fast harmonic rhythm and linear rhythm, I changed my beaming according to pulse. My attitude as a composer was—what is going to be easier for the performer and what rhythmic feeling do I want to bring out in the music? There is both a conflict and a necessary compromise between these two concepts. When I examined using harmonic rhythm, the complexity of linear rhythms could get lost unless somehow indicated by the composer. For example, in Figure 75, I used numbers above each grouping so the performer could accurately portray the *damaru yati.* If the flute grouped notes according to crotchet pulse, it would be more in sympathy with the guitar's crotchet harmonic rhythm. I was happy hearing either performance approach because both methods produced a satisfying musical outcome. I discovered that it was impossible to escape the harmonic rhythmic and linear rhythmic conflict; it was always present. What I found interesting is how this conflict is resolved and varied in Western composition and notation practice.

A linear rhythm can be explored both in a modal linear way and harmonically. Harmonically, a linear rhythm can be modified by changing the time signature to fit each rhythmic grouping. This idea was explored in Figure 73, and although the harmony here is modal, chromatic harmony can be easily substituted. Figure 74 is the same rhythm as Figure 73, except it is played in *tisra nadai* and against a regular pulse. It is purely linear, and the melodic and harmonic patterns are repeated for easy pattern recognition. However, in Figure 74, the more I altered pitch and harmony, the more the linear rhythm became less clear. Experimenting and manipulating these musical tensions, notations and structures within a composition and the confines of cultural expectations is contextually proportionate.

I found atonalism and the Western modal system similar when applying linear rhythm. I have started exploring atonalism and linear rhythm in my new compositions, not presented here. I have found I can use very complicated linear rhythms, especially if the rhythms are adapted to melodic and harmonic patterns idiosyncratic to a particular instrument. This allows a breadth of technical freedom beyond the use of traditional harmony, where melodic, rhythmic and harmonic techniques particular to specific instruments can be explored.

My final concern was that care must be taken not to ask too much of musicians unfamiliar with another culture's music. I have tried to achieve this in my compositions. For example, I would use Western notation if I could convey an Indian rhythmic concept clearly. It was only with a difficult linear rhythm that I chose to adapt Western notation to Indian concepts. This was primarily because I was composing for Western musicians; I would have chosen a different method if I were composing for Indian musicians. Compromise and careful thought should be given to the performer in conveying a cross-cultural musical concept. My intention in all the compositions here has been that the value of a new musical idea must be equal to the time and effort a performer is willing to put into learning it and any complications in notation should be avoided if possible.

12.3 Future Research: Korvai Construction, Representation, Memory and Rhythmic Education

I have deliberately extrapolated *konokol* into the wider context of linguistics, history and psychology because this is unexplored and problematic for future research. Finding evidence of the blind forces of evolution and an imposed logic in *konokol* would be a challenging research project.

Sections 12.2, 12.3 and 12.4 of this chapter speculate on a few discursive and potential frameworks for marrying new knowledge with Carnatic rhythms. My future aim is to marry disparate but related ideas that I could use creatively in compositions. While the success rate of this is subjective and unknown, the potential risk is studying *konokol* as an anthropological object and staying within the confines of this tradition. As a rhythmic learning device, I find no reason to go outside of the Carnatic tradition. However, my sincere interest is creatively marrying different ideas together.

To demonstrate possible future research regarding *konokol* in relation to memory, representation and education, it is worth re-analysing a *korvai* I used in *hamsadhvani* (see Figure 41), taken from Sankaran’s (2010) book *The Art of*

Konnakkol. This will demonstrate a few pertinent points on how *konokol* structures relate to memorisation and the construction of *korvais* in general. This will facilitate in the creation of one's own *korvais* in relation to improvisation and composition. There are, however, many possible ways to analyse a *korvai.* The demonstration here is just one of those ways.

The *korvai* in Table 14 and Table 15, has 6 *avartas* and 48 *aksaras,* it is a *gopucca yati* that begins with some symmetrical patterns followed by another *gopucca yati*. Although the syllables give an indication of the structure, this is only clearly understandable if numbers and *tala* are written along with *konokol* syllables. Like most *korvais*, it has a combination of macro, micro, binary and ternary structures that dovetail and link together through a pivot phrase. This fractal nature and chunking of patterns make *korvais* very easy to remember. Even in a simple *korvai* like this one, scripted representations can emphasise different structural elements involving syllables, numeracy, geometry and movement, all of which lead to a deeper understanding of its rhythm. There is no standard nomenclature for *konokol* and this can be useful because it allows for a variety of perspectives and approaches. Table 15 represents how I like to set out a *korvai* and is close to the South Indian tradition, although numbers are not always used. In Table 15, you can see the geometric structure of the syllables and the maths/*aksaras*, as well as follow the *tala*. These different written forms of *konokol* are a means to an end, which is to vocalise rhythmic patterns in *tala* with hand gestures without any form of notation. These differences are probably why no standard written form has ever evolved. There are too many varying musical styles and dialects in India to accommodate them all into a complete system. Any attempt to standardise a written form of *konokol* would be counter productive to its diversity.

Analysing a korvai from these different representations gives valuable insight, especially to musicians outside the Carnatic musical tradition. These representations fundamentally come from mathematical patterns and when *konokol* is thought of as mathematical, rather than cultural, it comes alive and can be used in any style of music without the fear and risk of creating cultural misunderstandings. When the evolutionary discourse of two disparate kinds of music becomes something other, unfortunately cultural offence is sometimes constructed in and around that other. Brown, in Born and Hesmondhalgh (2000,

p. 129), discusses more fully the formation of cultural theories and attitudes in relation to the mixing of cultural musical hierarchies. However, I prefer to see *konokol* as mathematics, a universal rhythmic system that transcends cultural attitudes. For example, mathematics is a language shared by all humans regardless of culture, religion or gender. This gives *konokol* universal educational value and there is no reason not to introduce it into mainstream Western music education. The only reasons I can think of for its absence in Western education are 1) a lack of exposure, and 2) that Western musical traditions view *konokol* as part of an Indian musical tradition rather than an aspect of mathematics. This is, however, changing with courses like 'Contemporary Music Through Non-Western Techniques' being offered at Amsterdam University and *konokol* courses being taught at Wesleyan University by David Nelson, which are the beginnings of an assimilated and unified practice.

In Table 14, the syllabic structure is outlined but does not show clearly the reduction. The syllables in lines 11, 12 and 13 are repeated two times and the third time in *tisra nadai* in lines 19, 20 and 21. Although the *nadai* is different in the last phrase, it is one idea that must be remembered vocally but functions differently mathematically. Depending on the *korvai,* the graphic structure cannot always be accurately represented because some phrases are too long to be written down linearly. When one feature is emphasised in written form there is always another that is compromised. Therefore, the different representations of *konokol* are valuable to analyse. Toussaint makes the same point and argues that geometric figures and numbers are universal objects of experience that yield novel insights that cannot be perceived through Western musical notation alone' (Toussaint, 2013, pp. 33–35). Nelson also makes extensive use of geometrical shapes in his explanation of *korvais* in *Mrdangam Mind: The Tani Avartenum in Karnatic Music* (Nelson 1991). Table 15 represents a more traditional way of writing out the same *korvai* used in Table 14. Here, the internal structure is not as clear; however, the *tala* cycle is clearly shown by the use of hand symbols.

Table 14: The internal structure of a *korvai* linking the macro, micro, binary and ternary structures and pivot phrases within its larger ternary structure—a good example of how memory and chunking have evolved in an aural musical tradition

1 (Column)					**2**		**3**		**4**		**5**	**6**		
Konokol patterns 1					Beats 2		Binary 3		Ternary		Pivot	Memory		
	A	B	C	D	E	F	G	H	I	J	K	L		
1	Ta. ta ri	ta jo nu .	Ta ka ta ri	. ta di mi	4	8	A B A B	A	A B A					1
2	Ta ka ta ri	ta jo nu .	Ta ka ta ri kita ta ka	Tam...	4									2
3	Ta ka ta ri	ta jo nu .	Ta ka ta ri	. ta di mi	4	8		B						3
4	Ta ka ta ri	ta jo nu .	Ta ka ta ri kita ta ka	Tam . . .	4					A B A				4
5	Ta. ta ri	ta jo nu .	Ta ka ta ri kita ta ka	Tam . . .	4	8	A B A B	A						5
6	Ta ka ta ri	ta jo nu .	Ta ka ta ri kita ta ka	Tam . . .	4			B	A A A					6
7			Ta ka ta ri kita ta ka	Tam . . .	2	4								7
8			Ta ka ta ri kita ta ka	Tam . . .	2									8
9			Ta ka ta ri kita ta ka	Tam .	1.5	3	A A	A						9
10			Ta ka ta ri kita ta ka	Tam .	1.5									10
11			Ta di .gi na tom		1.5	4.5		A	A A A					11
12			Ta di .gi na tom		1.5									12
13			Ta di .gi na tom		1.5									13
14			Ta...		1	1								14
15			Ta di .gi na tom		1.5	4.5		A	A A A					15
16			Ta di .gi na tom		1.5									16
17			Ta di .gi na tom		1.5									17
18			Ta...		1	1								18
19	*Tirsra nadai*		Ta di .gi na tom		1.5	6		A	A A A					19
20	*Tirsra nadai*		Ta di .gi na tom		1.5									20
21	*Tirsra nadai*		Ta di .gi na tom		1.5									21
22			Ta (*Sam*)		48 Total	1								22

Table 15: The same *korvai* as shown in Table 14 using traditional South Indian notation, which outlines the *tala* and its geometrical shape. X = clap, I= finger counts starting from the right-hand little finger and O= wave

	X I I I X O X O	
	Ta . ta ri . ta jo nu Ta ka ta ri . ta di mi Ta ka ta ri . ta jo nu Ta ka ta ri ki ta a ka Tam	8
	X I I I X O X O	
	Ta . ta ri . ta jo nu Ta ka ta ri . ta di mi Ta ka ta ri . ta jo nu Ta ka ta ri ki ta a ka Tam	8
	X I I I	
	Ta . ta ri . ta jo nu Ta ka ta ri ki ta a ka Tam ...	4
	X O X O	
	Ta ka ta ri . ta jo nu Ta ka ta ri ki ta a ka Tam ...	4
	X I	
	Ta ka ta ri ki ta a ka Tam ...	2
	X I	
	Ta ka ta ri ki ta a ka Tam ...	2
	X O	
	Ta ka ta ri ki ta a ka Tam .	1.5
	X	
	Ta ka ta ri ki ta a ka Tam .	1.5
	O X	
	Ta di . gi na tom	1.5
	I	
	Ta di . gi na tom	1.5
	I I	
	Ta di . gi na tom	1.5
	X	
	Ta . . .	1
	O	
	Ta di . gi na tom	1.5
	X O	
	Ta di . gi na tom	1.5
	X	
	Ta di . gi na tom	1.5
	I	
	Ta ...	1
	I I	
Tisra nadai	Ta di . gi na tom	2
	X O	
	Ta di . gi na tom	2
	X O	
	Ta di . gi na tom	2
	X	
	Ta (*Sam*) Total	48

One of the most interesting aspects in the study of *konokol* is the connection between dovetailing binary and ternary structures and the evolution of *konokol* and memory. There is no current research in relation to *konokol* and memory and it is an aspect that is often overlooked and taken for granted when learning *konokol.* I would strongly argue that these fractal and dovetailing structures have evolved naturally in a way that allows complex patterns to be effectively remembered. How and why these patterns have evolved is a primordial mystery that goes beyond the discourses of knowledge. However, it is in the connections between memory, numbers and patterns in these discourses that we get glimpses of understanding and construct knowledge. What is also important is why some patterns are left behind and others become useful to us. Answering this question in relation to *konokol* could shed light on questions about memory and our relationship to patterns and numbers.

Memory is a key component of *konokol*. The evidence for this is the lengthy performances and incredible memories of South Indian percussionists. Western musicians also have incredible memories: *konokol*, however, is memory essentially by mathematics, not by harmony, which is why it lends itself so well to sophisticated rhythms. An example of the lack of mathematical thinking in jazz would be the novice jazz player soloing over simple modal tunes and forgetting where the harmonic changes are. This often happens through a lack of mathematical thinking rather than a lack of harmonic knowledge.

An essential part of memory and *konokol* is the pivot phrase. For example, in column 6 of Table 14, the blacked-out areas are extremely important because they do not have to be remembered in the same way as do other phrases. They are pivots, linking together the larger phrases on either side. In fact, they do not need to be remembered at all, because this information has been repeated previously. What must be remembered is that the initial phrase is repeated three times. The pivot phrase is a determining factor linking variations of binary and ternary structures together. The coloured blocks demonstrate three large chunks of condensed information, which individually can also be divided into smaller groups of three. This demonstrates that simple information can be transformed into something complex without compromising form and memory. In a composition like *Variations on Bhimpalasi*, it is unlikely that the performers will memorise the composition or in fact perceive these structures. However, they will have a psychoacoustic effect on the audience and performer because the audience will subconsciously identify and connect these patterns with other non-musical patterns. Foucault (1997, p. 69) in *The Order of Things* refers to this as the imagination of resemblance where the instability of signs and patterns establish themselves in knowledge-making relations, measurements and identities.

However, to someone who knows *konokol*, hearing these phrases should enable them to easily mentally identify these patterns with *konokol* syllables and perhaps identify them with other non-musical phenomena.

Many of these phrases have a deep connection to the evolution of how we remember patterns. Even when the audience is not conscious of this patterning, it still has a significant impact on the listener. There must be a consubstantial relationship to the patterning in our perceptions and brains to other phenomena, otherwise, we might not recognise the patterns in the first place. Even though we cannot always prove the meaning and relationship of these patterns with other phenomena, many interesting parallels can make us wonder why this is so, and just for that reason they are worth analysing. Foucault (1997, pp. 69–71) frames this connection as nature and human nature within the confines of an episteme that allows a reconciliation of resemblance and imagination that provides and makes possible the empirical sciences of order.

12.4 Creativity, Evolution, Numbers and the Path of Least Resistance.

Numbers influence the psyche in relation to quantitative and qualitative computations. However, Feigenson (2011, p. 13) suggests it is the numbers three and four that have a direct relationship with the amount of stored information in working memory at any one time. However, humans are also capable of difficult quantification feats achieved through three representations: individual object, sets of objects and an ensemble of objects. This chunking process is also how complex *konokol* compositions are compartmentalised and memorised in Carnatic music. Arguably, the aural tradition of *konokol* has evolved through a collective consciousness, the outcome of which is a combination of the blind but complex forces of life and an externally imposed logic (Waddington, 1966, p. 47). I found that *korvais* in particular demonstrate the use of working memory through an individual object, sets of objects and an ensemble of objects; it seems also that Carnatic music demonstrates a combination of the blind complexes of life and human logic.

The forces of nature take the easiest path of formation, creating numerical patterns in organic matter and sometimes human-made creations. As an example the internal structure of a vulture's wing and a warren truss used in engineering similarly demonstrate, the number three, triangular shapes, strength and lightness (Waddington, 1966, p. 47; see Figure 81).

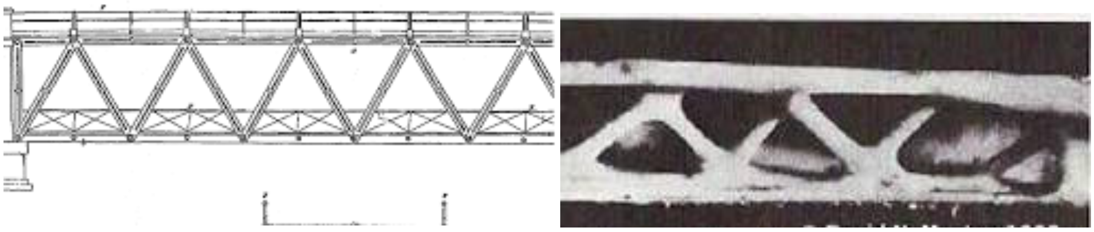


Figure 81: Demonstrating an evolutionary pull towards the number 3 using triangles, strength and minimal material

The number three is aesthetically pleasing across cultures: it represents the beginning of patterns and is essential to memory and structure (Lundy, 2001, p. 3). For example, there are three primary colours; a pivot chord connects two different keys; there are holy trinities in many major religions; there are five three-dimensional solids; and *mukthayams* consist of a phrase repeated three times. Lundy examines many numbers that like each other, and although there is no mention of *konokol* in her book, the numerical parallels are worth noting. The portal door of Gerum Church in Sweden is constructed 3 x 11 = 33 (Figure 82), The portal door x 3 takes up the area of the inner entrance and the portal door x 11 takes up the area of the entire entrance: 3 x 11 is also a very common *tihai*. Christ was resurrected in three days; the sun takes 33 years before it rises over the same point on the horizon; if the moon has a radius of 3, then the earth's radius is 11 (Lundy, 2001, pp. 16–18). To the mathematician, the world is numbers and, logical or not, I have found examining *konokol* structures and integrating them with other numerical systems useful as compositional material. However, while many numbers have their uniqueness, it is the combinations of one-digit numbers that construct the larger frameworks in *konokol* compositions.

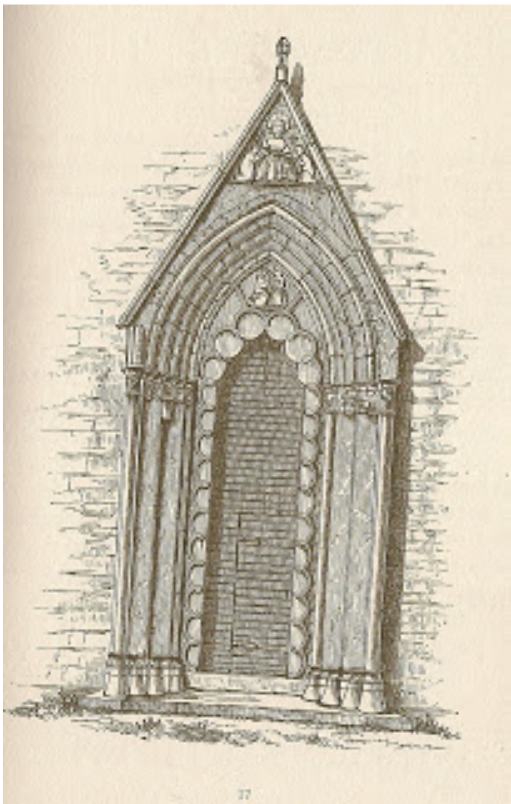


Figure 82: The portal door of the Gerum Church in Sweden shows a deliberate 3 by 11 construction (Lundy, 2001, p. 17)

12.5 Konokol, Memory, the Body and Numbers in the Brain

The linking of music, nature and numbers is not new. However, there is little research on the evolution of *konokol* and its relationship to memory, number and the body. The most used numbers in *konokol* are 4, 3, 7, 5 and 9. If we relate these to the body, we have four limbs, three brains (the cerebrum the limbic system and the hippocampus), ten fingers, seven holes in our head, nine holes in our total body and 32 adult teeth, which are the number of *aksaras* in third speed in *adi tala*. Single-digit numbers are easier to remember and are the path of least resistance that enables complicated numerosity. I would argue that an examination of numerical cultural memes and the mathematical codes found in nature could reveal both the blind complexities of nature and human imposed logic existing in Carnatic rhythms. Current psychological research shows that numbers are an entity already within us:

> Over the past decades, however, it has become clear that basic numerical competence does not depend on language and education, but is rooted in biological primitives that can be explored in innumerate indigenous cultures, infants, and even animals. Comparative psychologists have shown that animals can discriminate numerosities (i.e., the cardinality of a set, set size) (Brannon & Terrace 1998, Davis & Perusse 1988), and field studies have convincingly demonstrated that animals use numerical information on a regular basis to make informed decisions (e.g., in foraging or in social interactions such as fights) (Hauser et al. 2000, Mc Comb et al. 1994, Wilson et al. 2001). These findings highlight the evolutionary significance of numerical competence; processing numerical information is important to guarantee an animal's survival. (Nieder & Dehaene, 2009, p. 186)

The history and evolution of memory, number and *konokol* would be an interesting research topic because *konokol* has evolved through a collective consciousness. Rather than the behaviourist's approach of understanding memory and pattern through abstract experiments, *konokol*, memory and pattern recognition could be understood through collective memory. Any experiments testing number and pattern recognition in relation to memory should examine the patterns in *konokol* because it is these patterns that enable memorisation to take place. For example, the purpose of *konokol* is the memorising and singing of complex mathematical sequences exercised through a mnemonic relationship between numbers, geometric shape and an arbitrary alphabet. There is some neuroscientific research by (Nieder & Dehaene 2009) that supports my argument that number is already in the brain. For example, experiments with monkeys in neuroscience involving the activity in the brain in relation to shape and number have shown a connection between number and arbitrary shape. If a number is already in the brain, it must permeate all other aspects of human endeavour, especially with activities that involve memorisation:

> To investigate the single-neuron mechanisms by which a number symbol becomes attached to the corresponding numerosity, Diester and Nieder (2007) trained two monkeys to associate the *a priori* meaningless visual shapes of Arabic numerals with the inherently meaningful numerosity of multiple-dot displays. After this long-term learning process was completed, a relatively large

> proportion of PFC neurons[15] encoded plain numerical values, irrespective of whether they had been presented as a specific number of dots or as a visual sign. (Nieder & Dehaene, 2009, p. 186)

It is impossible to imagine the world without mathematics, and it is indisputable that humans have developed superior mathematical skills. The findings in neuroscience, psychology and anthropology show that numerical skills are rooted in non-linguistic biological imperatives. Other experiments with monkeys using numerical illusions and cross-modal numerical adaptions involving different senses indicate that animals can numerically cross-reference between auditory and visual modalities. These can include spatial extent, number, time, memory, symbolic recognition, object recognition, chunking and magnitude information. All are key elements in the understanding of psychology and perception, and all are elements embedded in the *konokol* system. Current research connects memory, mathematics and numerical cognition across different sensory modalities. For example, in 'Objects, Sets and Ensembles' Feigenson (2011) analysed objects, sets and ensembles in relation to working memory. Her conclusions about numerical computations and working memory in the brain are not dissimilar to the way in which memory and *konokol* patterns work together. What I find absent in the literature on mathematics and the brain is any exploration of the aural traditions that use mathematics and symbolic human languages. Moreover, much of the subject matter in psychology and neuroscience relating to memory, number and pattern recognition have been developed in *konokol* over centuries. For example, embedded in *konokol's* history is a collective human consciousness that integrates a relationship between pattern recognition, memory, rhythm and mathematics, making konokol a subject seriously worth researching in relation to other disciplines.

[15] The prefrontal cortex (PFC) regulates behaviours.

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Appendix A: The Application of the Ta Di Gi Na Tom Family of Rhythms to the Classical and Plectrum Guitar

Appendix A
Ta di gi na toms no gaps 5, 6, 7, 8, 9, 10

X I I I X O X O ||X

Khanda 5+5+5=15

. . . . | . . . . | . . . . | . . . . | . ta di gi |na tom ta di |gi na tom ta | di gi na tom||

Tisra 6+6+6=18

tam . . . | . . . . | . . . . | . . ta di | . gi na tom | ta di . gi |na tom ta di |. gi na tom ||

Misra 7+7+7=21

tam . . . | . . . . | . . . ta | . di . gi | na tom ta . | di . gi na | tom ta . di |. gi na tom ||

Chatursra 8+8+8=24

tam . . . | . . . . | ta di . gi | . na . tom | ta di . gi | . na . tom | ta . di . | gi . na tom||

Sankirma 9+9+9=27

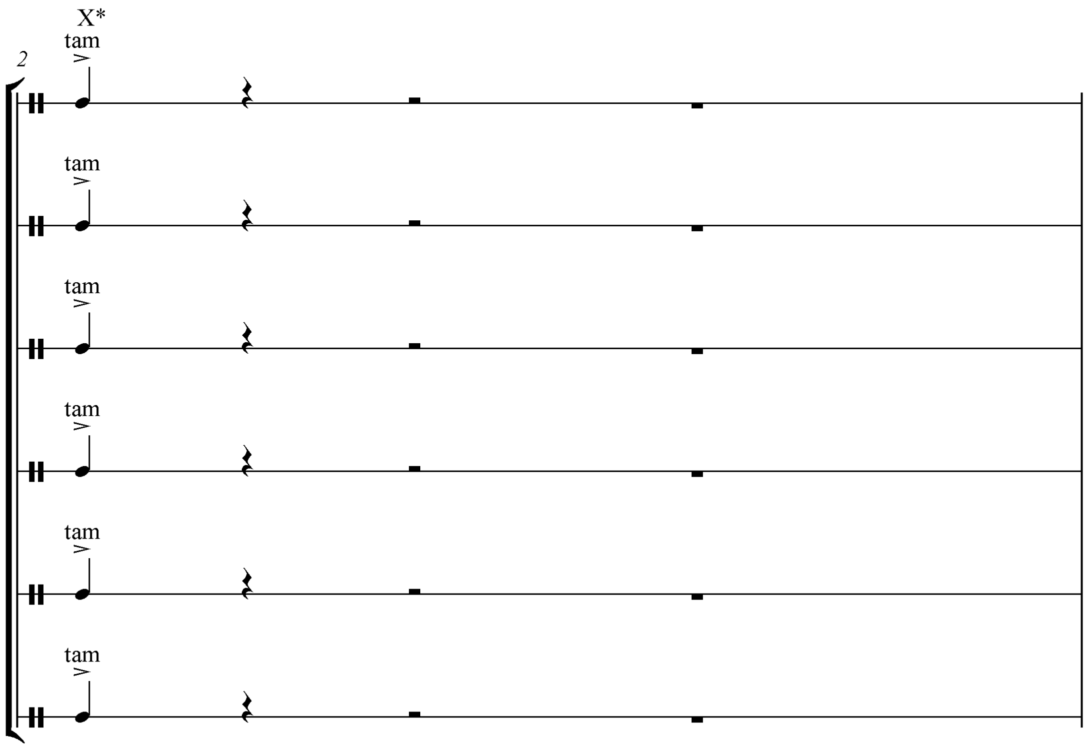
tam . . . | . ta . di | . gi . na | . tom ta . | di . gi . | na . tom ta | . di . gi | . na . tom ||

Sampoorna khanda 10+10+10=30

X

tam. ta ki | ta dim . ta | di gi na tom | ta dim . gi |na tom ta dim | . gi na tom | ta ki ta dim |ta di gi na tom || tam

Ta di gi na tom patterns 5, 6 ,7, 8, 9 and 10



Ta di gi na toms no gaps
for guitar

Ta di gi na toms no gaps
for guitar continued

Ta di gi na toms with semiquaver gap (one karvai)

X I I I X O X O ||X

Khanda (5+1)+(5+1)+5=17

| . . . . | . . . . | . . . . | . . . | ta di gi na | tom . ta di | gi na . ta | di gi na tom||

Tisra (6+1)+(6+1)+6=21

| tam . . . | . . . . | . . . | ta di . gi | na tom . ta | di . gi na | tom . ta . | di gi na tom ||

Misra (7+1)+(7+1)+7=23

| tam . . . | . . . . | . ta . di | . gi na tom | . ta . di | . gi na tom | . ta . di | . gi na tom ||

Chatursra (8+1)+(8+1)+8=26

| tam . . . | . . ta di | . gi . na | . tom . ta | di . gi . | na . tom . | ta di . gi | . na . tom ||

Sankirma (9+1)+(9+1)+9=29

| tam . . ta | . di . gi | . na . tom | . ta . di | . gi . na | . tom . ta | . di . gi | . na . tom ||

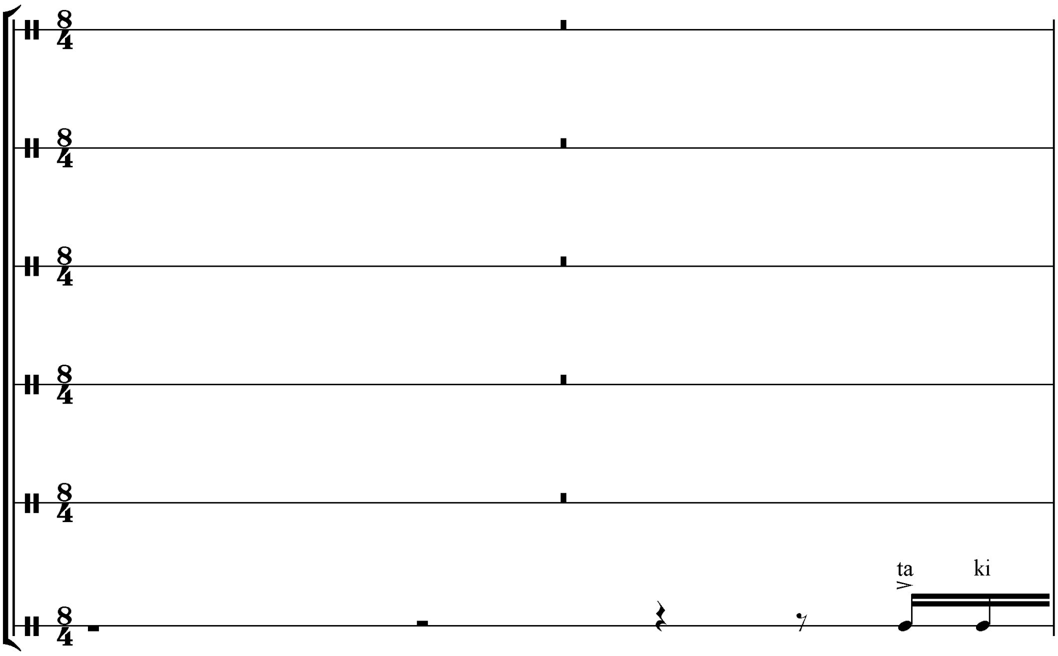
Sampoorna khanda (10+1)+(10+1)+10=32

| ta ki ta dim | . ta di gi | na tom . ta | ki ta dim . | ta di gi na | tom . ta ki | ta dim . ta | di gi na tom || tam

Ta di gi na toms with semiquaver gap (one karvai) for guitar

Ta di gi na toms
semiquaver gap (one karvai) for guitar continued

Ta di gi na toms with quaver gap (two karvai)



X I I I X O X O ||X

Khanda (5+2)+(5+2)+5=19

| . . . . | . . . . | . . . . | . ta di gi | na tom . . | ta di gi na| tom . . ta | di gi na tom|

Tisra (6+2)+(6+2)+6=22

| tam . . . | . . . . | . . ta di | . gi na tom | . . ta di | . gi na tom | . . ta di | . gi na tom |

Misra (7+2)+(7+2)+7=25

| tam . . . | . . . ta | . di . gi | na tom . . | ta . di . |gi na tom . | . ta . di | . gi na tom |

Chatursra (8+2)+(8+2)+8=28

| tam . . . | ta di . gi | . na . tom | . . ta di | . gi . na | . tom . . | ta di . gi | . na . tom |

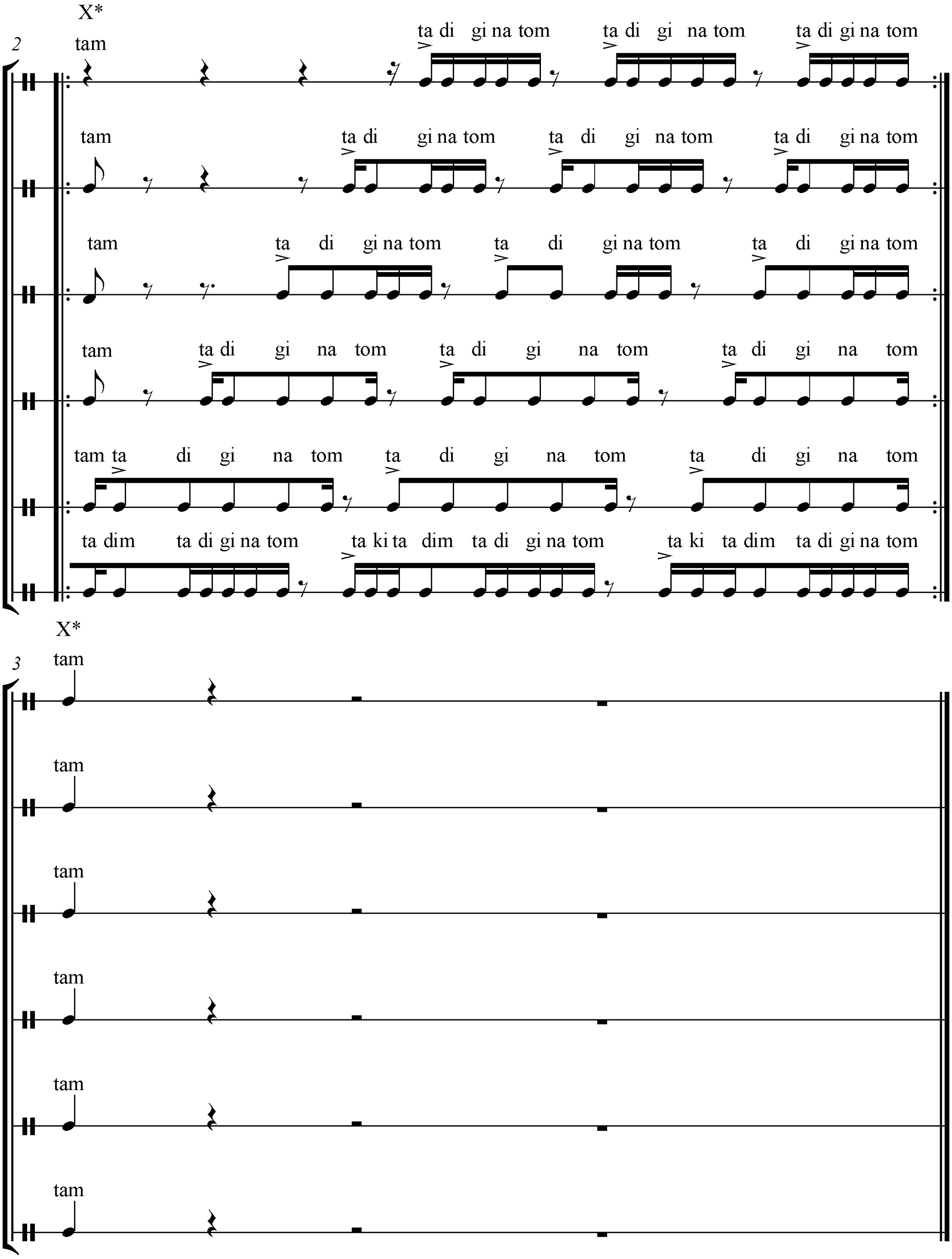
Sankirma (9+2)+(9+2)+9=31

| tam ta . di | . gi . na | . tom . . | ta . di . | gi . na . | tom . . ta | . di . gi | . na . tom |

Sampoorna khanda (10+2)+(10+2)+10=34

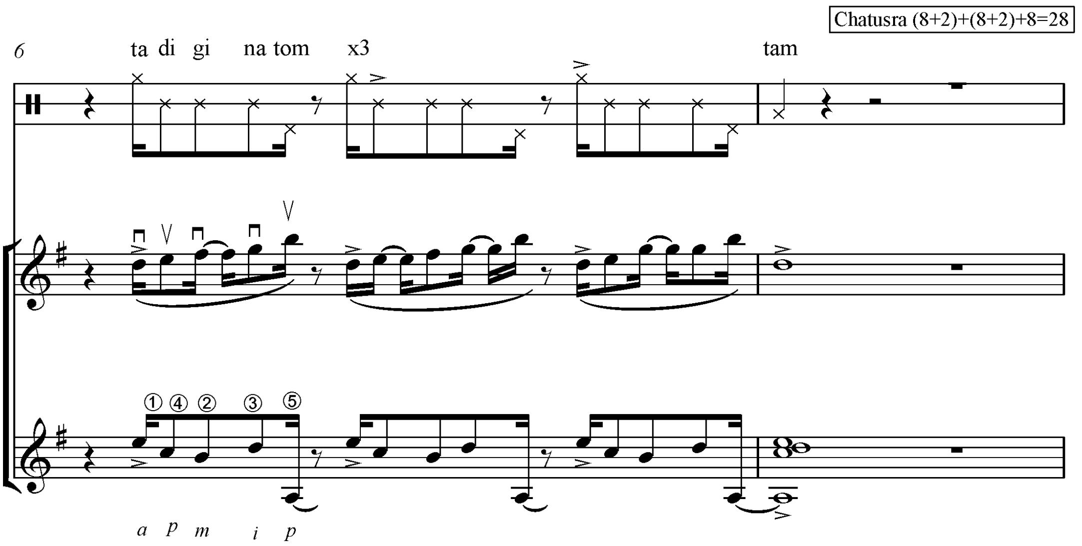
ta ki | ta dim . ta | di gi na tom | . . ta ki | ta dim . ta | di gi na tom | . . ta ki | ta dim . ta | di gi na tom|| tam |

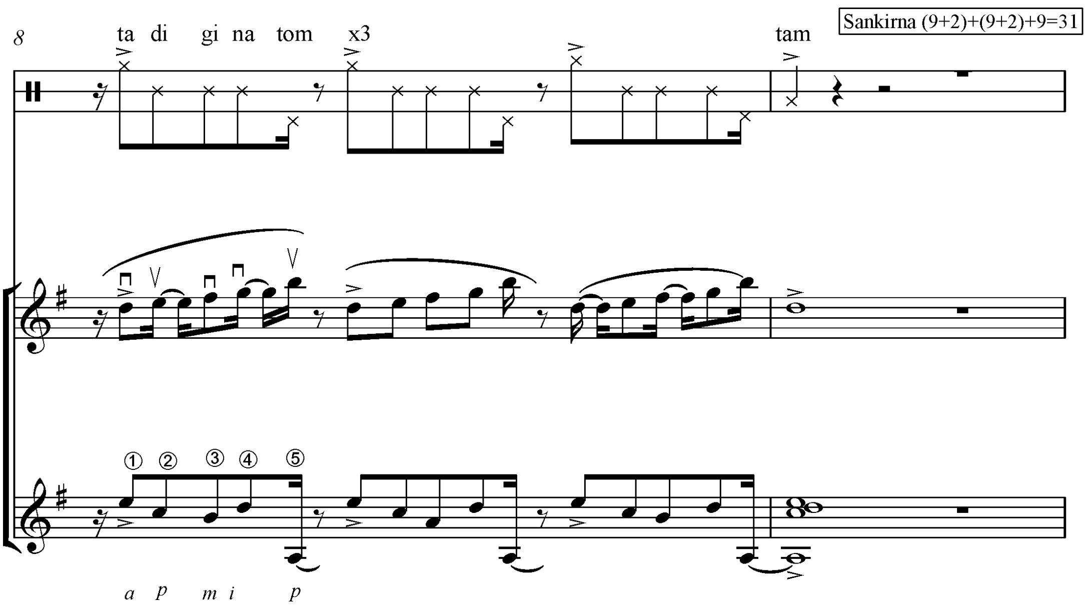
Ta di gi na toms with quaver gap (two karvai) continued



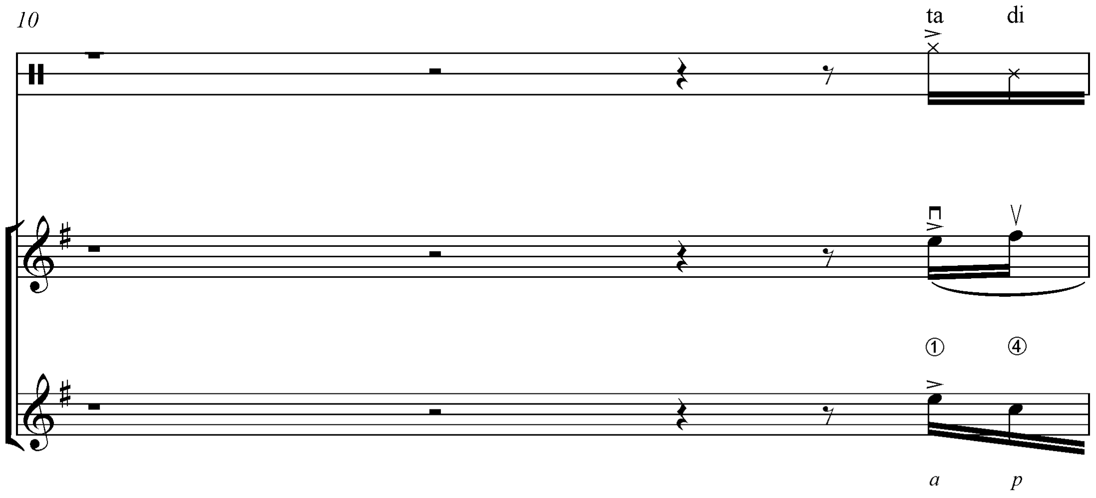
Ta di gi na toms with quaver gap or (two karvai) for guitar

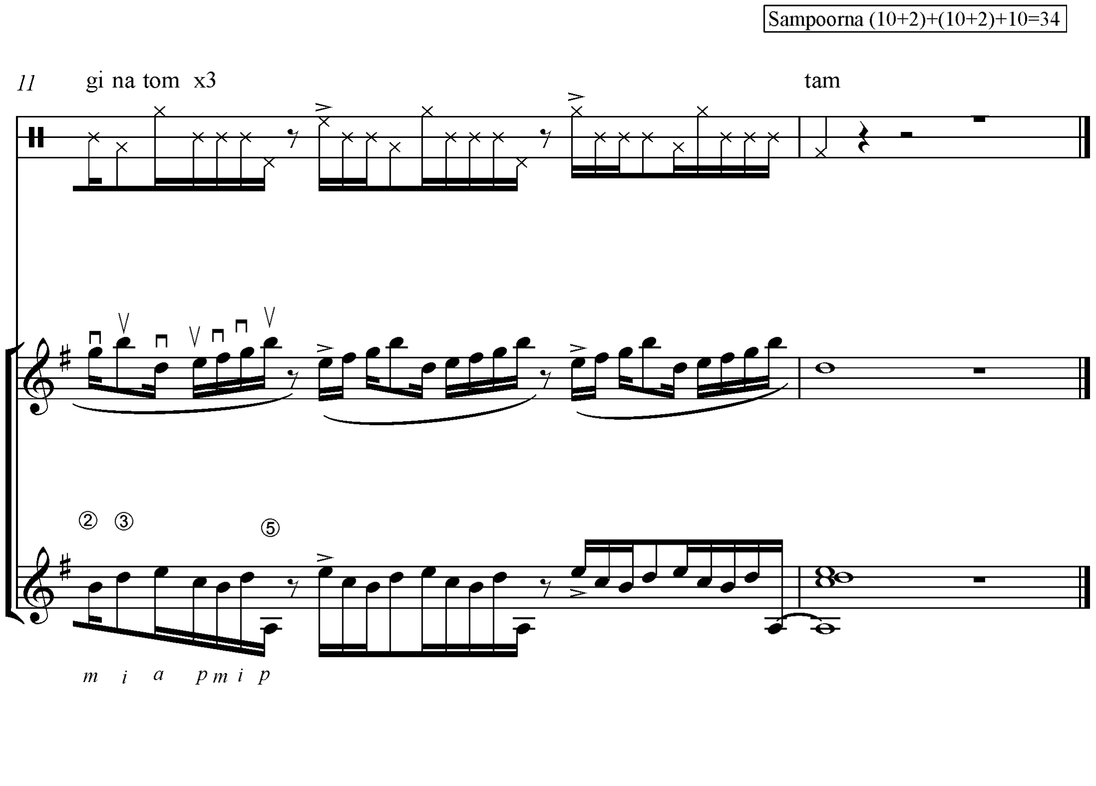
Ta di gi na toms with quaver gaps or (two karvai) for guitar continued



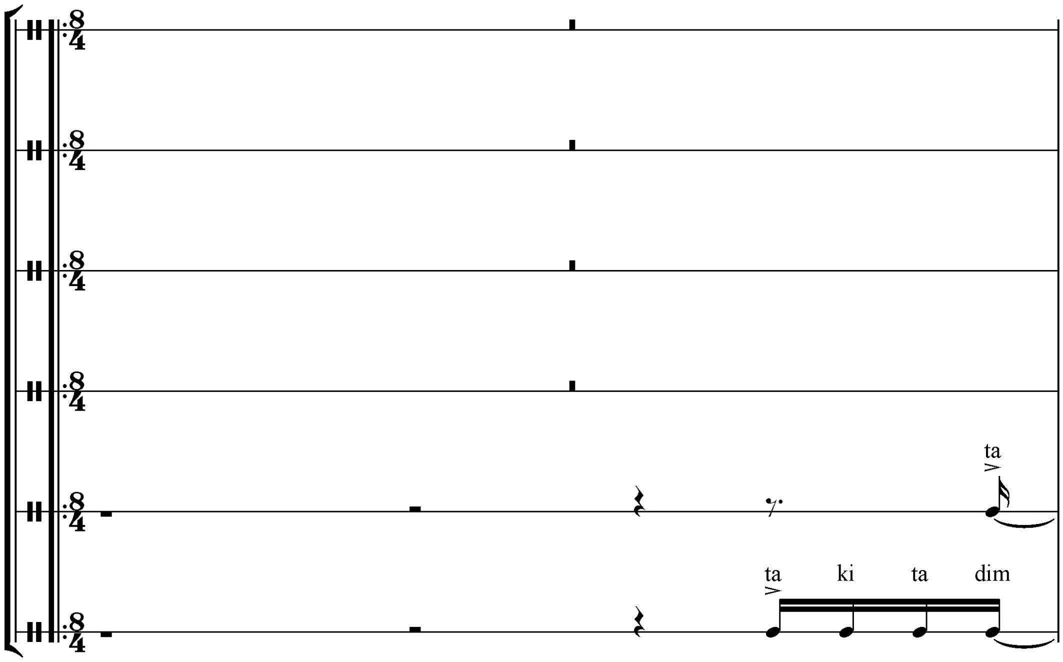


Ta di gi na toms with quaver gaps or (two karvai) for guitar continued





Ta di gi na toms with dotted quaver gap (three karvai)



X I I I X O X O ||X

Khanda (5+3)+(5+3)+5=21

| . . . . | . . . . | . . . ta |di gi na tom | . . . ta |di gi na tom| . . . ta | di gi na tom|

Tisra (6+3)+(6+3)+6=24

|tam . . . | . . . . |ta di . gi |na tom . . | . ta di .| gi na tom . | . . ta di | . gi na tom |

Misra (7+3)+(7+3)+7=27

|tam . . . |. ta . di |.gi na tom | . . . ta | . di . gi |na tom . . |. ta . di | . gi na tom |

Chatursra (8+3)+(8+3)+8=30

|tam .ta di| . gi . na |. tom . . |. ta di . | gi . na . |tom . . . |ta di . gi | . na . tom |

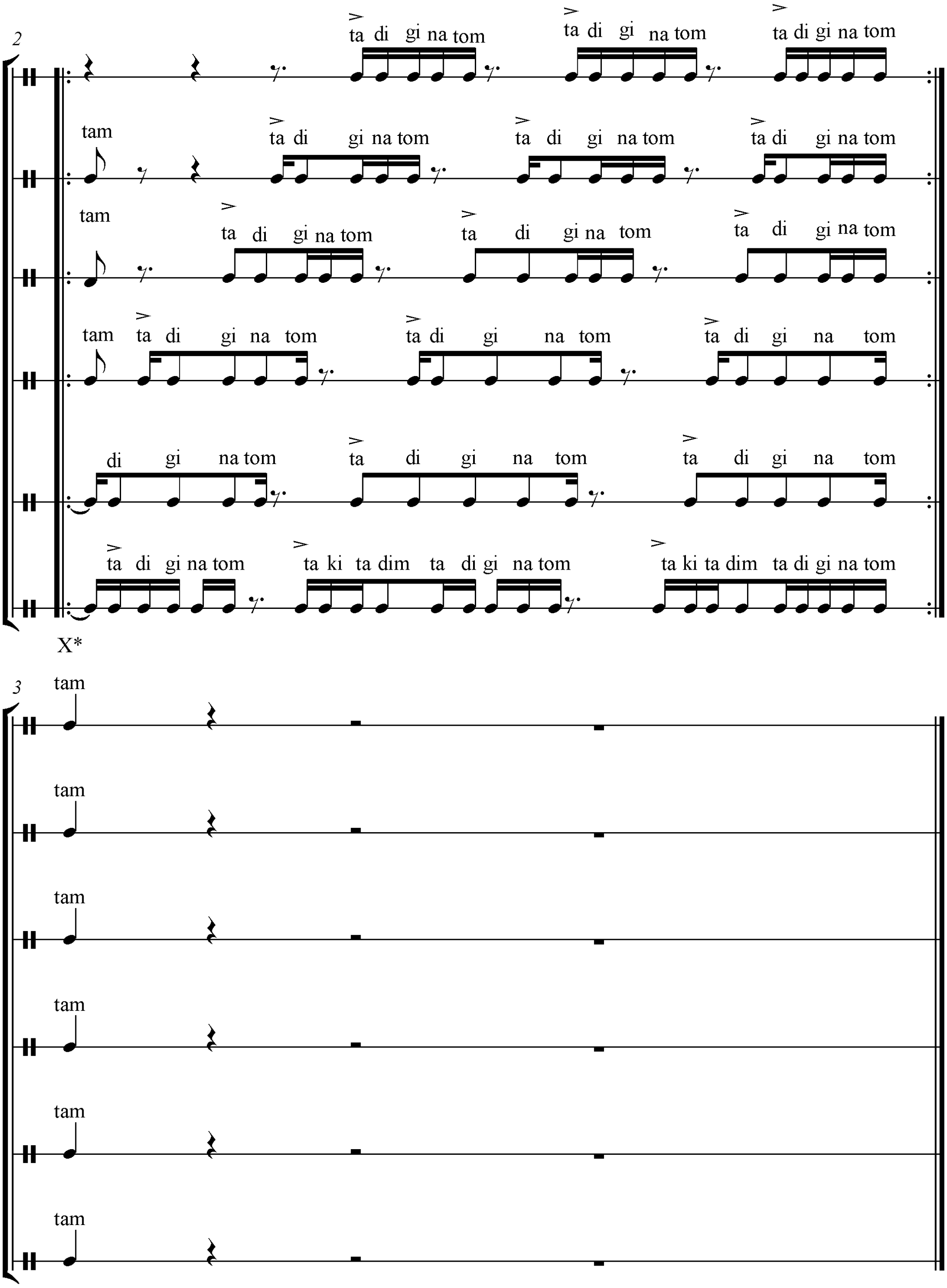
Sankirma (9+3)+(9+3)+9=33

ta |. di . gi | . na . tom |. . . ta |. di . gi | . na . tom | . . . ta | . di . gi | . na . tom |

Sampoorna khanda (10+3)+(10+3)+10=36

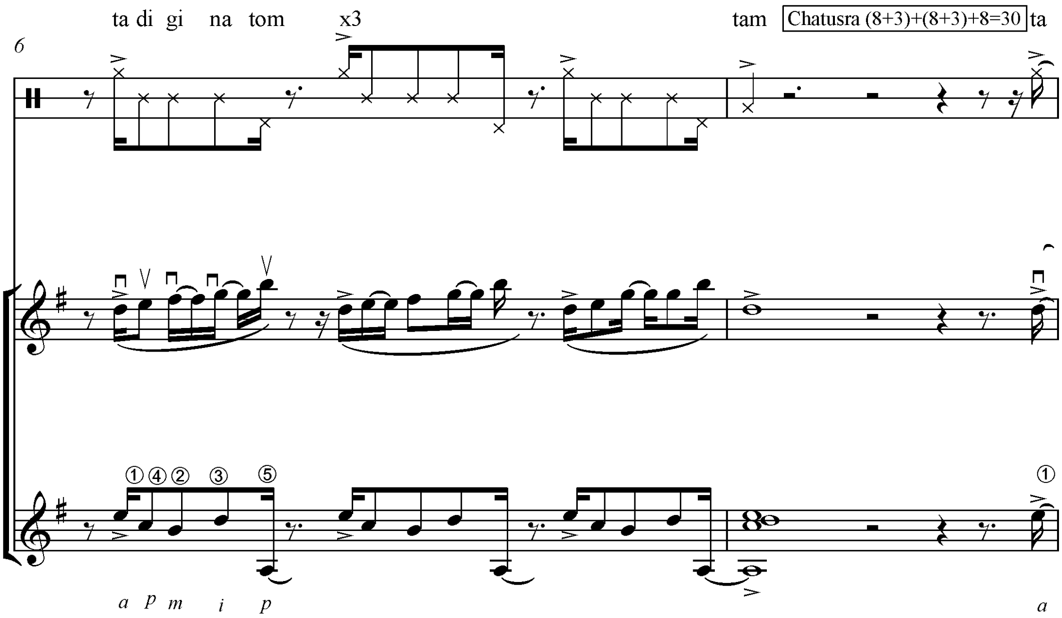
|ta ki ta dim |. ta di gi |na tom . .|. ta ki ta |dim . ta di |gi na tom . |. . ta ki | ta dim .ta | di gi na tom|| tam

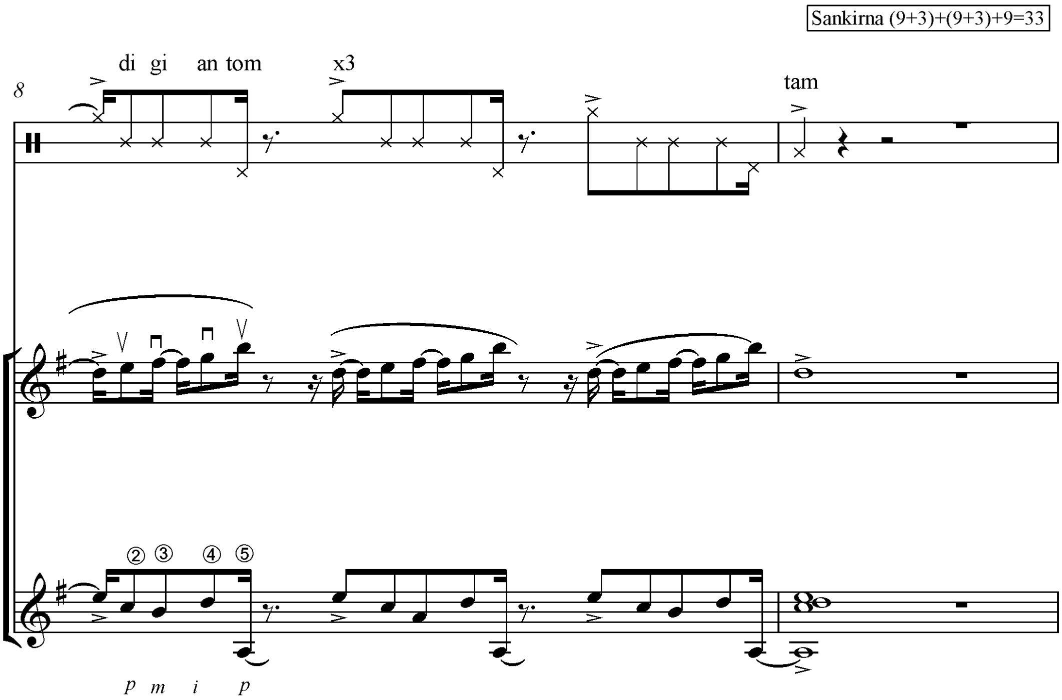
Ta di gi na toms with dotted quaver gap (three karvai) continued



Ta di gi na thoms with dotted quaver gap (three karvai) for guitar

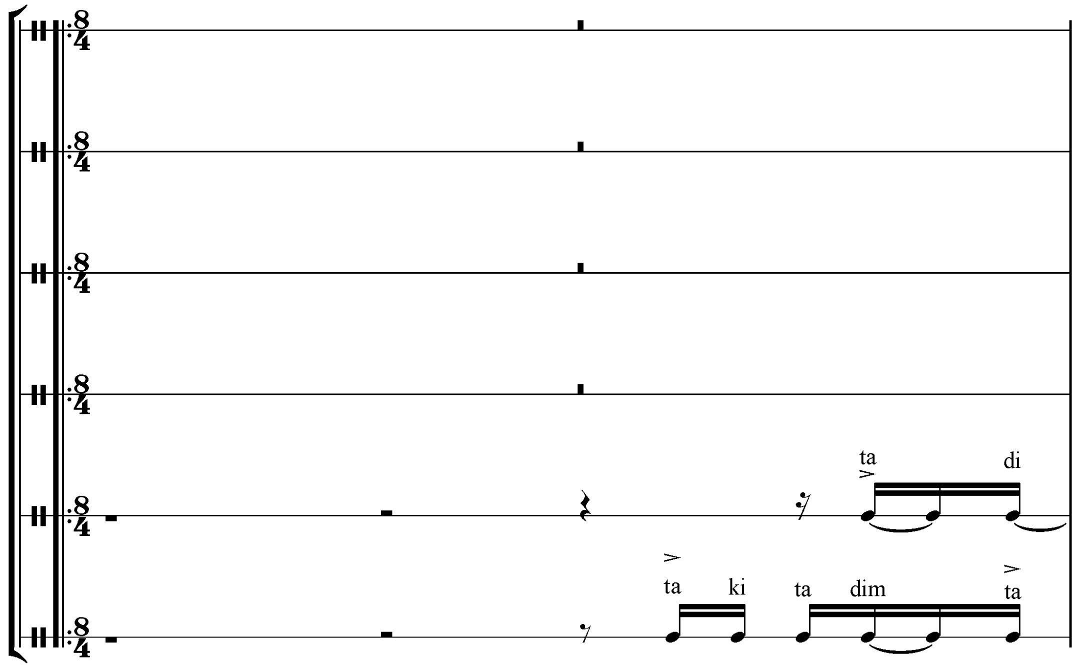
Ta di gi na toms with dotted quaver gap (three karvai) for guitar continued





Ta di gi na toms with
dotted quaver gap (three karvai) for guitar continued

Ta di gi na toms with crotchet gap (four karvai)



X O X I I I X O X O ||X

Khandа (5+4)+(5+4)+5=23

|. . . . |. . . . | . ta di gi |na tom . . |. . ta di |gi na tom . | . . . ta | di gi na tom|

Tisra (6+4)+(6+4)+6=26

|tam . . .|. . ta di |.gi na tom |. . . . | ta di . gi |na tom . . | . . ta di | . gi na tom |

Misra (7+4)+(7+4)+7=29

| . . ta | . di . gi |na tom . .| . . ta . |di . gi na |tom . . . | . ta . di | . gi na tom |

Chatursra (8+4)+(8+4)+8=32

|ta di . gi |. na .tom| . . . . | ta di . gi | . na . tom | . . . . | ta di . gi | . na . tom |

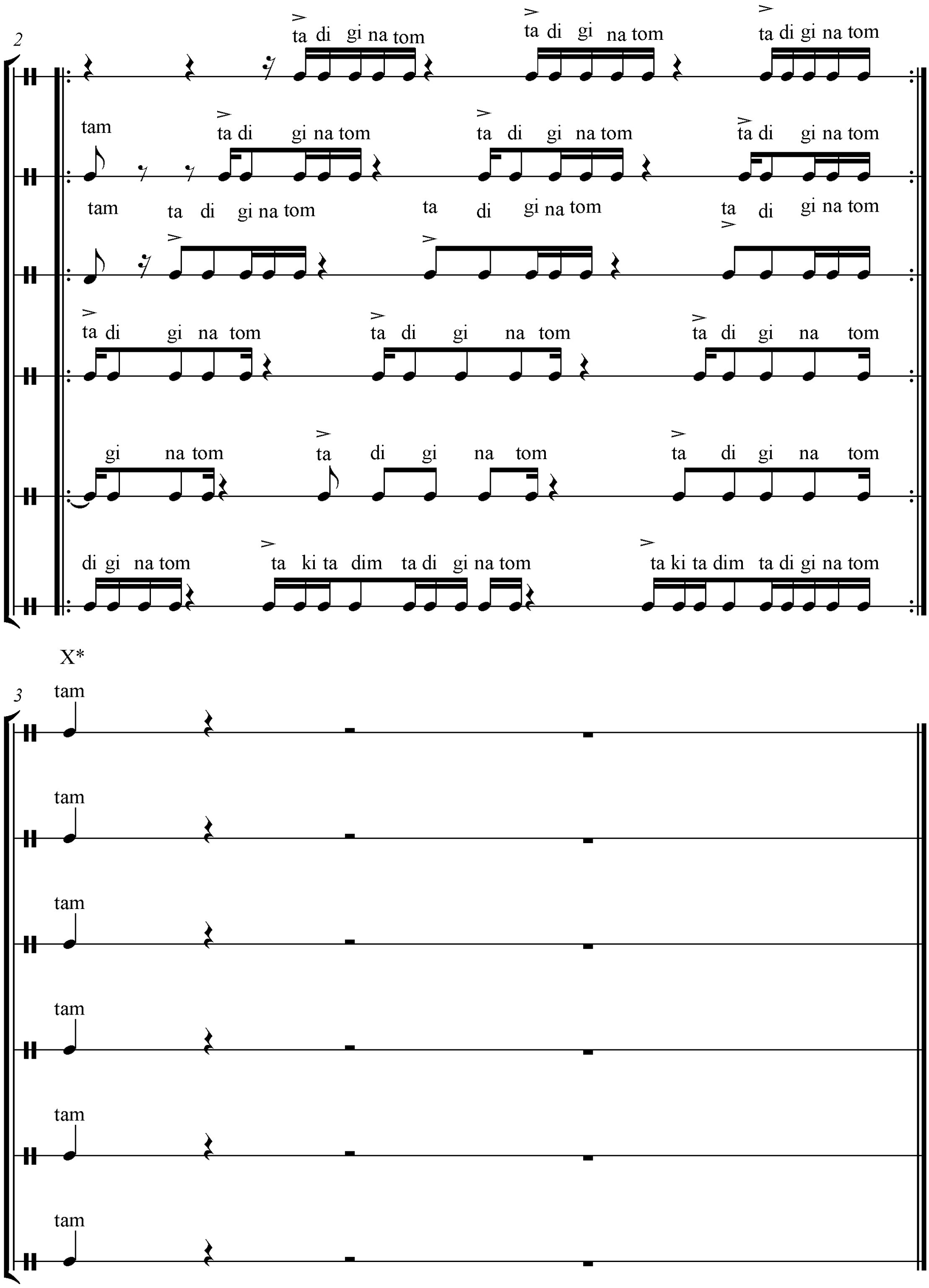
Sankirma (9+4)+(9+4)+9=35

ta . di | . gi . na |.tom . . | . . ta . | di . gi . | na . tom . |. . . ta | . di . gi | . na . tom |

Sampoorna khanda (10+4)+(10+4)+10=38

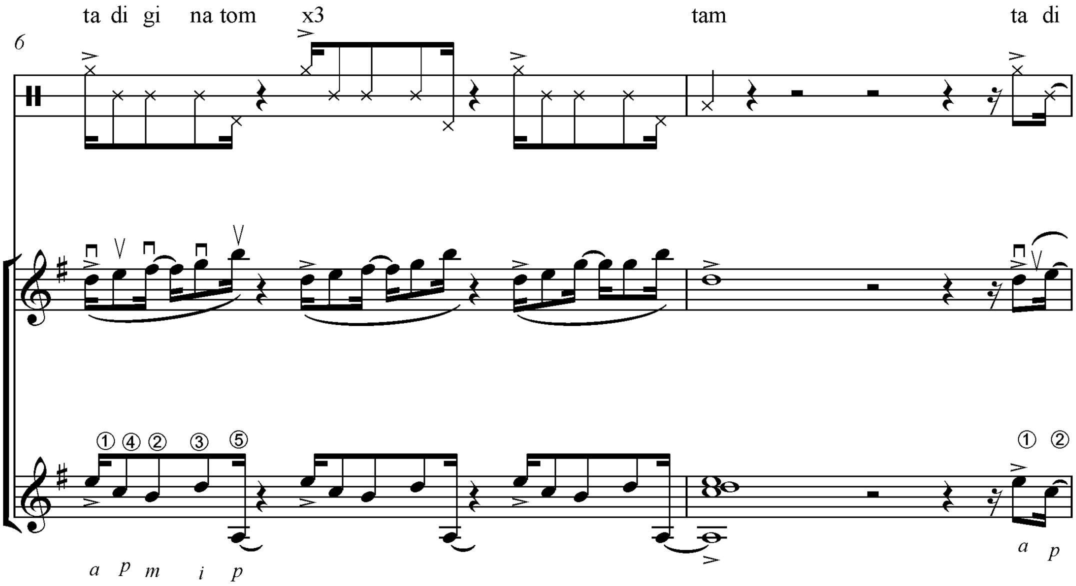
|. .ta ki | ta dim . ta |di gi na tom| . . . . |ta ki ta dim |. ta di gi |na tom . . |. . ta ki |ta dim .ta|di gi na tom|| tam

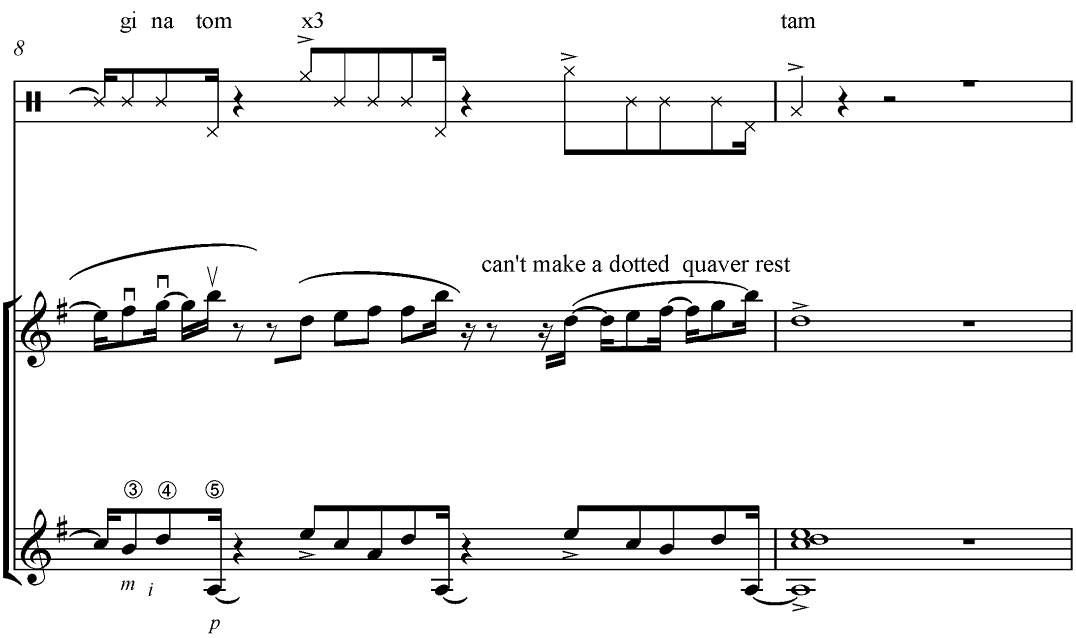
Ta di gi na toms with crotchet gap (four karvai) continued



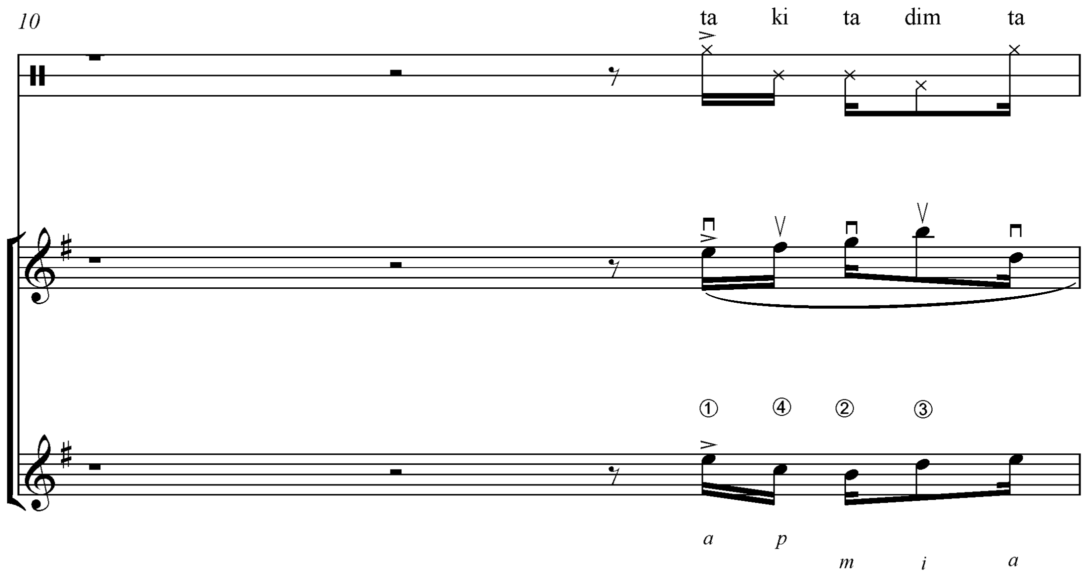
Ta di gi na toms with crotchet gap (four karvais) for guitar

Ta di gi na toms with crotchet gap (four karvais) for gutiar continued





Ta di gi na toms with crotchet gap (four karvais) for guitar continued



Appendix B: Mukthayam Graphs (Gap = Karvai)

Groupings of 2

Graph 1									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			6	8	10	12	14	16	18
2 cycles			12	16	20	24	28	32	36
3 cycles			18	24	~~30~~	~~36~~	~~42~~	~~48~~	~~54~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
6	2,2,2		0	2	4	6	8	10	4
8	2^12^12		4	0	2	4	6	8	2
10	2^22^22		2	6	0	2	4	6	8
12	2^32^32	3+3+3	0	4	8	0	2	4	6
14	2^42^42		4	2	6	10	0	2	4

Graph 2									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			9	12	15	18	21	24	27
2 cycles			18	24	30	~~36~~	~~42~~	48	54
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
6	2,2,2		3	6	9	12	15	18	21
8	2^12^12		1	4	7	10	13	16	19
10	2^22^22		8	2	5	8	11	14	17
12	2^32^32	3+3+3	6	0	3	6	9	12	15
14	2^42^42		4	10	1	4	7	10	13

Graph 3									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			12	16	20	24	28	32	36
2 cycles			24	32	40	~~48~~	~~56~~	~~64~~	~~72~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
6	2,2,2		6	10	14	18	22	26	30
8	2^12^12		4	8	12	16	20	24	28
10	2^22^22		2	6	10	14	18	22	26
12	2^32^32	3+3+3	0	4	8	12	16	20	24
14	2^42^42		10	2	6	10	14	18	22

Graph 4									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			15	20	25	30	35	40	45
2 cycles			30	40	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
6	2,2,2		9	14	19	24	29	34	39
8	$2^1 2^1 2$		7	12	17	22	27	32	37
10	$2^2 2^2 2$		5	10	15	20	25	30	35
12	$2^3 2^3 2$	3+3+3	3	8	13	18	23	28	33
14	$2^4 2^4 2$		1	6	11	16	21	26	31

Graph 5									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			18	24	30	36	42	48	54
2 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
6	2,2,2		12	18	24	30	36	42	48
8	$2^1 2^1 2$		10	16	22	28	34	40	46
10	$2^2 2^2 2$		8	14	20	26	32	38	44
12	$2^3 2^3 2$	3+3+3	6	12	18	24	30	36	42
14	$2^4 2^4 2$		4	10	16	22	28	34	40

Graph 6									
Mukthayam 7 pulses per beat *tala* or time signature									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
6	2,2,2		15	22	29	36	43	50	57
8	$2^1 2^1 2$		13	20	27	34	41	48	55
10	$2^2 2^2 2$		11	18	25	32	39	46	53
12	$2^3 2^3 2$	3+3+3	9	16	23	30	37	44	51
14	$2^4 2^4 2$		7	14	21	28	35	42	49

Graph 7									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
6	2,2,2		18	26	34	42	50	58	66
8	$2^1 2^1 2$		16	24	32	40	48	56	64
10	$2^2 2^2 2$		14	22	30	38	46	54	62
12	$2^3 2^3 2$	3+3+3	12	20	28	36	44	52	60
14	$2^4 2^4 2$		10	18	26	34	42	50	58

Graph 8									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
6	2,2,2		21	30	39	48	57	66	75
8	$2^1 2^1 2$		19	28	37	46	55	64	73
10	$2^2 2^2 2$		17	26	35	44	53	62	71
12	$2^3 2^3 2$	3+3+3	15	24	33	42	51	60	69
14	$2^4 2^4 2$		13	22	31	40	49	58	67

Groupings of 3

Graph 9									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	10	12	14	16	18
2 cycles			12	16	20	24	28	32	36
3 cycles			18	24	~~30~~	~~36~~	~~42~~	~~48~~	~~54~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
9	3,3,3		3	7	1	3	5	7	9
11	$3^1 3^1 3$		1	5	9	1	17	5	7
13	$3^2 3^2 3$		5	3	7	11	15	3	5
15	$3^3 3^3 3$	5+5+5	3	1	5	9	13	1	3
17	$3^4 3^4 3$		1	7	3	7	11	15	1

Graph 10									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			9	12	15	18	21	24	27
2 cycles			18	24	30	~~36~~	~~42~~	48	54
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	Gap
9	3,3,3		0	3	6	9	12	15	18
11	$3^1 3^1 3$		7	1	4	7	10	13	16
13	$3^2 3^2 3$		5	11	2	5	8	11	14
15	$3^3 3^3 3$	5+5+5	3	9	0	3	6	9	12
17	$3^4 3^4 3$		1	7	13	1	4	7	10

Graph 11									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			12	16	20	24	28	32	36
2 cycles			24	32	40	~~48~~	~~56~~	~~64~~	~~72~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	Gap
9	3,3,3		3	7	11	15	19	23	27
11	$3^1 3^1 3$		1	5	9	13	17	21	25
13	$3^2 3^2 3$		11	3	7	11	15	19	23
15	$3^3 3^3 3$	5+5+5	9	1	5	9	13	17	21
17	$3^4 3^4 3$		7	15	3	7	11	15	19

Graph 12									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			15	20	25	30	35	40	45
2 cycles			30	40	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			Gap	gap	gap	gap	gap	gap	gap
9	3,3,3		6	11	16	21	26	31	36
11	$3^1 3^1 3$		4	9	14	19	24	29	34
13	$3^2 3^2 3$		2	7	12	17	22	27	32
15	$3^3 3^3 3$	5+5+5	0	5	10	15	20	25	30
17	$3^4 3^4 3$		13	3	8	13	18	23	28

Graph 13									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			18	24	30	36	42	48	54
2 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
9	3,3,3		9	15	21	27	33	39	45
11	$3^1 3^1 3$		7	13	19	25	31	37	43
13	$3^2 3^2 3$		5	11	17	23	29	35	41
15	$3^3 3^3 3$	5+5+5	3	9	15	21	27	33	39
17	$3^4 3^4 3$		1	7	13	19	25	31	37

Graph 14									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
9	3,3,3		12	19	26	33	40	47	54
11	$3^1 3^1 3$		10	17	24	31	38	45	52
13	$3^2 3^2 3$		8	15	22	29	36	43	50
15	$3^3 3^3 3$	5+5+5	6	13	20	27	34	41	48
17	$3^4 3^4 3$		4	11	18	25	32	39	46

Graph 15									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
9	3,3,3		15	23	31	39	47	55	63
11	$3^1 3^1 3$		13	21	29	37	45	53	61
13	$3^2 3^2 3$		11	19	27	35	43	51	59
15	$3^3 3^3 3$	5+5+5	9	17	25	33	41	49	57
17	$3^4 3^4 3$		7	15	23	31	39	47	55

Graph 16									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
9	3,3,3		18	27	36	45	54	63	72
11	$3^1 3^1 3$		16	25	34	43	52	61	70
13	$3^2 3^2 3$		14	23	32	41	50	59	68
15	$3^3 3^3 3$	5+5+5	12	21	30	39	48	57	66
17	$3^4 3^4 3$		10	20	28	37	46	55	64

Groupings of 4

Graph 17									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	12	14	16	18
2 cycles			~~12~~	~~16~~	~~20~~	24	28	32	36
3 cycles			~~18~~	~~24~~	~~30~~	36	42	48	54
4 cycles			~~24~~	~~32~~	~~40~~	48	56	64	72
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		0	4	8	0	2	4	6
14	$4^1 4^1 4$		4	2	6	10	0	2	4
16	$4^2 4^2 4$		2	0	4	8	12	0	2
18	$4^3 4^3 4$	6+6+6	0	6	2	6	10	14	0
20	$4^4 4^4 4$		4	4	0	4	8	12	16

Graph 18									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	15	18	21	24	27
2 cycles			18	24	30	36	42	48	54
3 cycles			27	~~36~~	~~45~~	~~54~~	~~63~~	~~72~~	~~81~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		6	0	3	6	9	12	15
14	$4^1 4^1 4$		4	10	1	4	7	10	13
16	$4^2 4^2 4$		2	8	14	2	5	8	11
18	$4^3 4^3 4$	6+6+6	0	6	12	0	3	6	9
20	$4^4 4^4 4$		7	4	10	16	1	4	7

Graph 19									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			12	16	20	24	28	32	36
2 cycles			24	32	40	~~48~~	~~56~~	~~64~~	~~72~~
3 cycles			~~36~~	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		0	4	8	12	16	20	24
14	$4^{1}4^{1}4$		10	2	6	10	14	18	22
16	$4^{2}4^{2}4$		8	0	4	8	12	16	20
18	$4^{3}4^{3}4$	6+6+6	6	14	2	6	10	14	18
20	$4^{4}4^{4}4$		4	12	0	4	8	12	16

Graph 20									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			15	20	25	30	35	40	45
2 cycles			30	40	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		3	8	13	18	23	28	33
14	$4^{1}4^{1}4$		1	6	11	16	21	26	31
16	$4^{2}4^{2}4$		14	4	9	14	19	24	29
18	$4^{3}4^{3}4$	6+6+6	12	2	7	12	17	22	27
20	$4^{4}4^{4}4$		10	0	5	10	15	20	25

Graph 21									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			18	24	30	36	42	48	54
2 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		6	12	18	24	30	36	42
14	$4^{1}4^{1}4$		4	10	16	22	28	34	40
16	$4^{2}4^{2}4$		2	8	14	20	26	32	38
18	$4^{3}4^{3}4$	6+6+6	0	6	12	18	24	30	36
20	$4^{4}4^{4}4$		16	4	10	16	22	28	34

Graph 22									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		9	16	23	30	37	44	51
14	$4^{1}4^{1}4$		7	14	21	28	35	42	49
16	$4^{2}4^{2}4$		5	12	19	26	33	40	47
18	$4^{3}4^{3}4$	6+6+6	3	10	17	24	31	38	45
20	$4^{4}4^{4}4$		1	8	15	22	29	36	43

Graph 23									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		12	20	28	36	44	52	60
14	$4^{1}4^{1}4$		10	18	26	34	42	50	58
16	$4^{2}4^{2}4$		8	16	24	32	40	48	56
18	$4^{3}4^{3}4$	6+6+6	6	14	22	30	38	46	54
20	$4^{4}4^{4}4$		4	12	20	28	36	44	52

Graph 24									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
12	4,4,4		15	24	33	42	51	60	69
14	$4^{1}4^{1}4$		13	22	31	40	49	58	67
16	$4^{2}4^{2}4$		11	20	29	38	47	56	65
18	$4^{3}4^{3}4$	6+6+6	9	18	27	36	45	54	63
20	$4^{4}4^{4}4$		7	16	25	34	43	52	61

Groupings of 5

Graph 25									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	16	18
2 cycles			12	16	20	24	28	32	36
3 cycles			18	24	30	~~36~~	~~42~~	~~48~~	~~54~~
4 cycles			24	~~32~~	~~40~~	~~48~~	~~56~~	~~64~~	~~72~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		3	1	5	9	13	1	3
17	$5^1 5^1 5$		1	7	3	7	11	15	1
19	$5^2 5^2 5$		5	5	1	5	9	13	17
21	$5^3 5^3 5$	7+7+7	3	3	9	3	7	11	15
23	$5^4 5^4 5$		1	1	7	1	5	9	11

Graph 26									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	15	18	21	24	27
2 cycles			18	24	30	36	42	48	54
3 cycles			27	~~36~~	~~45~~	~~54~~	~~63~~	~~72~~	~~81~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		3	9	0	3	6	9	12
17	$5^1 5^1 5$		1	7	13	1	4	7	10
19	$5^2 5^2 5$		8	5	11	17	2	5	8
21	$5^3 5^3 5$	7+7+7	6	3	9	15	0	3	6
23	$5^4 5^4 5$		4	1	7	13	19	1	4

Graph 27									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	16	20	24	28	32	36
2 cycles			24	32	40	~~48~~	~~56~~	~~64~~	~~72~~
3 cycles			~~36~~	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		9	1	5	9	13	17	21
17	$5^1 5^1 5$		7	15	3	7	11	15	19
19	$5^2 5^2 5$		5	13	1	5	9	13	17
21	$5^3 5^3 5$	7+7+7	3	11	19	3	7	11	15
23	$5^4 5^4 5$		1	9	17	1	5	9	13

Graph 28									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			15	20	25	30	35	40	45
2 cycles			30	40	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		0	5	10	15	20	25	30
17	5^15^15		13	3	8	13	18	23	28
19	5^25^25		11	1	6	11	16	21	26
21	5^35^35	7+7+7	9	19	4	9	14	19	24
23	5^45^45		7	17	2	7	12	17	22

Graph 29									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			18	24	30	36	42	48	54
2 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		3	9	15	21	27	33	39
17	5^15^15		1	7	13	19	25	31	37
19	5^25^25		17	5	11	17	23	29	35
21	5^35^35	7+7+7	15	3	9	15	21	27	33
23	5^45^45		13	1	7	13	19	25	31

Graph 30									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	5,5,5		6	13	20	27	34	41	48
17	5^15^15		4	11	18	25	32	39	46
19	5^25^25		2	9	16	23	30	37	44
21	5^35^35	7+7+7	0	7	14	21	28	35	42
23	5^45^45		19	5	12	19	26	33	40

Graph 31									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
15	5,5,5		9	17	25	33	41	49	57
17	$5^1 5^1 5$		7	15	23	31	39	47	55
19	$5^2 5^2 5$		5	13	21	29	37	45	53
21	$5^3 5^3 5$	7+7+7	3	11	19	27	35	43	51
23	$5^4 5^4 5$		1	9	17	25	33	41	49

Graph 32									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
15	5,5,5		12	21	20	39	48	57	66
17	$5^1 5^1 5$		10	19	18	37	46	55	64
19	$5^2 5^2 5$		8	17	16	35	44	53	62
21	$5^3 5^3 5$	7+7+7	6	15	14	33	42	51	60
23	$5^4 5^4 5$		4	13	12	31	40	49	58

Graph 33									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	~~16~~	18
2 cycles			12	16	20	24	28	32	36
3 cycles			18	24	30	36	~~42~~	~~48~~	~~54~~
4 cycles			24	32	~~40~~	~~48~~	~~56~~	~~64~~	~~72~~
5 cycles			30	~~40~~	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
18	6,6,6		0	6	2	6	10	14	0
20	$6^1 6^1 6$		4	4	0	4	8	12	16
22	$6^2 6^2 6$		2	2	8	2	6	10	14
24	$6^3 6^3 6$	8+8+8	0	0	6	0	4	8	12
26	$6^4 6^4 6$		4	6	4	10	2	6	10

Groupings of 6

Graph 34									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	~~15~~	18	21	24	27
2 cycles			18	24	30	36	42	48	~~54~~
3 cycles			27	36	~~45~~	~~54~~	~~63~~	~~72~~	~~81~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
18	6,6,6		0	6	12	0	3	6	9
20	$6^1 6^1 6$		7	4	10	16	1	4	7
22	$6^2 6^2 6$		5	2	8	14	20	2	5
24	$6^3 6^3 6$	8+8+8	3	0	6	12	18	0	3
26	$6^4 6^4 6$		1	10	4	10	16	22	1

Graph 35									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	~~16~~	20	24	28	32	36
2 cycles			24	32	40	48	56	64	72
3 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
18	6,6,6		6	12	2	6	10	14	18
20	$6^1 6^1 6$		4	12	0	4	8	12	16
22	$6^2 6^2 6$		2	10	18	2	6	10	14
24	$6^3 6^3 6$	8+8+8	0	8	16	0	4	8	12
26	$6^4 6^4 6$		10	6	14	22	2	6	10

Graph 36									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~15~~	20	25	30	35	40	45
2 cycles			30	40	50	~~60~~	~~70~~	~~80~~	~~90~~
3 cycles			~~45~~	~~60~~	~~75~~	~~90~~	~~105~~	~~120~~	~~135~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
18	6,6,6		12	2	7	12	17	22	27
20	$6^1 6^1 6$		10	0	5	10	15	20	25
22	$6^2 6^2 6$		8	18	3	8	13	18	23
24	$6^3 6^3 6$	8+8+8	6	16	1	6	11	16	21
26	$6^4 6^4 6$		4	14	24	4	9	14	19

Graph 37									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			18	24	30	36	42	48	54
2 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
18	6,6,6		0	6	12	18	24	30	36
20	$6^1 6^1 6$		16	4	10	16	22	28	34
22	$6^2 6^2 6$		14	2	8	14	20	26	32
24	$6^3 6^3 6$	8+8+8	12	0	6	12	18	24	30
26	$6^4 6^4 6$		10	22	4	10	16	22	28

Graph 38									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
18	6,6,6		3	10	17	24	31	38	45
20	$6^1 6^1 6$		1	8	15	22	29	36	43
22	$6^2 6^2 6$		20	6	13	20	27	34	41
24	$6^3 6^3 6$	8+8+8	18	4	11	18	25	32	39
26	$6^4 6^4 6$		16	2	9	16	23	30	37

Graph 39									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
1 cycles			48	~~63~~	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
18	6,6,6		6	14	22	30	38	46	54
20	$6^1 6^1 6$		4	12	20	28	36	44	52
22	$6^2 6^2 6$		2	10	18	26	34	42	50
24	$6^3 6^3 6$	8+8+8	0	8	16	24	32	40	48
26	$6^4 6^4 6$		22	6	14	22	30	38	46

Graph 40									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
15	6,6,6		12	21	30	39	48	57	66
17	$6^1 6^1 6$		10	19	28	37	46	55	64
19	$6^2 6^2 6$		8	17	26	35	44	53	62
21	$6^3 6^3 6$	8+8+8	6	15	24	33	42	51	60
23	$6^4 6^4 6$		4	13	22	31	40	49	58

Groupings of 7

Graph 41									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	~~16~~	~~18~~
2 cycles			~~12~~	~~16~~	~~20~~	24	28	32	36
3 cycles			~~18~~	24	30	36	42	~~48~~	~~54~~
4 cycles			24	~~32~~	~~40~~	~~48~~	~~56~~	~~60~~	~~72~~
5 cycles			30	~~40~~	~~50~~	~~60~~	~~70~~	~~76~~	~~90~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
21	7,7,7		3	3	9	3	7	11	15
23	$7^1 7^1 7$		1	1	7	1	5	9	13
25	$7^2 7^2 7$		5	7	5	11	3	7	11
27	$7^3 7^3 7$	9+9+9	3	5	3	9	1	5	9
29	$7^4 7^4 7$		1	3	1	7	13	3	7

Graph 42									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	~~15~~	~~18~~	21	24	27
2 cycles			18	24	30	36	42	48	54
3 cycles			27	36	~~45~~	~~54~~	~~63~~	~~72~~	~~81~~
4 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
21	7,7,7		6	3	9	15	0	3	6
23	$7^1 7^1 7$		4	1	7	13	19	1	4
25	$7^2 7^2 7$		2	11	5	11	17	23	2
27	$7^3 7^3 7$	9+9+9	0	9	3	9	15	21	0
29	$7^4 7^4 7$		7	7	1	7	13	19	25

Graph 43									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	~~16~~	~~20~~	24	28	32	36
2 cycles			24	32	40	48	56	~~64~~	~~72~~
3 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
21	7,7,7		3	11	19	3	7	11	15
23	$7^{1}7^{1}7$		1	9	17	1	5	9	13
25	$7^{2}7^{2}7$		11	7	15	23	3	7	11
27	$7^{3}7^{3}7$	9+9+9	9	5	13	21	1	5	9
29	$7^{4}7^{4}7$		7	3	11	19	27	3	7

Graph 44									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~15~~	~~20~~	25	30	35	40	45
2 cycles			30	40	50	~~60~~	~~70~~	~~80~~	~~90~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
21	7,7,7		9	19	4	9	14	19	24
23	$7^{1}7^{1}7$		7	17	2	7	12	17	22
25	$7^{2}7^{2}7$		5	15	0	5	10	15	20
27	$7^{3}7^{3}7$	9+9+9	3	13	23	3	8	13	18
29	$7^{4}7^{4}7$		1	11	21	1	6	11	16

Graph 45									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~18~~	24	30	36	42	48	54
2 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	Gap
21	7,7,7		15	3	9	15	21	27	33
23	$7^{1}7^{1}7$		13	25	7	13	19	25	31
25	$7^{2}7^{2}7$		11	23	5	11	17	23	29
27	$7^{3}7^{3}7$	9+9+9	9	21	3	9	15	21	27
29	$7^{4}7^{4}7$		7	19	1	7	13	19	25

Graph 46									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	56	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
21	7,7,7		0	7	14	21	28	35	42
23	$7^1 7^1 7$		19	5	12	19	26	33	40
25	$7^2 7^2 7$		17	3	10	17	24	31	38
27	$7^3 7^3 7$	9+9+9	15	1	8	15	22	29	36
29	$7^4 7^4 7$		13	27	6	13	20	27	34

Graph 47									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
2 cycles			48	~~64~~	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
21	7,7,7		3	11	19	27	35	43	51
23	$7^1 7^1 7$		1	9	17	25	33	41	49
25	$7^2 7^2 7$		23	7	15	23	31	39	47
27	$7^3 7^3 7$	9+9+9	21	5	13	21	29	37	45
29	$7^4 7^4 7$		19	3	11	19	27	35	43

Graph 48									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
2 cycles			54	~~72~~	~~90~~	~~108~~	~~126~~	~~144~~	~~162~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
21	7,7,7		6	15	24	33	42	51	60
23	$7^1 7^1 7$		4	13	22	31	40	49	58
25	$7^2 7^2 7$		2	11	20	29	38	47	56
27	$7^3 7^3 7$	9+9+9	0	9	18	27	36	45	54
29	$7^4 7^4 7$		25	7	16	25	34	43	52

Groupings of 8

Graph 49									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	~~16~~	~~18~~
2 cycles			~~12~~	~~16~~	~~20~~	24	28	32	36
3 cycles			~~18~~	24	30	36	42	~~48~~	~~54~~
4 cycles			24	32	40	~~48~~	~~56~~	~~60~~	~~72~~
5 cycles			30	~~40~~	~~50~~	~~60~~	~~70~~	~~76~~	~~90~~
6 cycles			36	~~48~~					
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		0	0	6	0	4	8	12
26	$8^1 8^1 8$		4	6	4	10	2	6	10
28	$8^2 8^2 8$		2	4	2	8	0	4	8
30	$8^3 8^3 8$	10+10+10	0	2	0	6	12	2	6
32	$8^4 8^4 8$		4	0	8	4	10	0	4

Graph 50									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	~~15~~	~~18~~	~~21~~	24	27
2 cycles			~~18~~	24	30	36	42	48	54
3 cycles			27	36	45	~~54~~	~~63~~	~~72~~	~~81~~
4 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		3	0	6	12	18	0	3
26	$8^1 8^1 8$		1	10	4	10	16	22	1
28	$8^2 8^2 8$		8	8	2	8	14	20	26
30	$8^3 8^3 8$	10+10+10	6	6	0	6	12	18	24
32	$8^4 8^4 8$		4	4	13	4	10	16	22

Graph 51

Mukthayam 4 pulses per beat

Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	~~16~~	~~20~~	24	28	32	36
2 cycles			24	32	40	48	56	~~64~~	~~72~~
3 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		0	8	16	0	4	8	12
26	$8^1 8^1 8$		10	6	14	22	2	6	10
28	$8^2 8^2 8$		8	4	12	20	0	4	8
30	$8^3 8^3 8$	10+10+10	6	2	10	18	26	2	6
32	$8^4 8^4 8$		4	0	8	16	24	0	4

Graph 52

Mukthayam 5 pulses per beat

Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~15~~	~~20~~	25	30	35	40	45
2 cycles			30	40	50	60	~~70~~	~~80~~	~~90~~
3 cycles			45	~~60~~	~~75~~	~~90~~	~~105~~	~~120~~	~~135~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		6	16	1	6	11	16	21
26	$8^1 8^1 8$		4	14	24	4	9	14	19
28	$8^2 8^2 8$		2	12	22	2	7	12	17
30	$8^3 8^3 8$	10+10+10	0	10	20	0	5	10	15
32	$8^4 8^4 8$		13	8	18	28	3	8	13

Graph 53

Mukthayam 6 pulses per beat

Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~18~~	24	30	36	42	48	54
2 cycles			36	48	60	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		12	0	6	12	18	24	30
26	$8^1 8^1 8$		10	22	4	10	16	22	28
28	$8^2 8^2 8$		8	20	2	8	14	20	26
30	$8^3 8^3 8$	10+10+10	6	18	0	6	12	18	24
32	$8^4 8^4 8$		4	16	28	4	8	16	22

Graph 54									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			21	28	35	42	49	56	63
2 cycles			42	56	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		18	4	11	18	25	32	39
26	$8^1 8^1 8$		16	2	9	16	23	30	37
28	$8^2 8^2 8$		14	0	7	14	21	28	35
30	$8^3 8^3 8$	10+10+10	12	26	5	12	19	26	33
32	$8^4 8^4 8$		10	24	3	10	17	24	31

Graph 55									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			24	32	40	48	56	64	72
2 cycles			48	~~64~~	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		0	8	16	24	32	40	48
26	$8^1 8^1 8$		22	6	14	22	30	38	46
28	$8^2 8^2 8$		20	4	12	20	28	36	44
30	$8^3 8^3 8$	10+10+10	18	2	10	18	26	34	42
32	$8^4 8^4 8$		16	0	8	16	24	32	40

Graph 56									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
2 cycles			54	~~72~~	~~90~~	~~108~~	~~126~~	~~144~~	~~162~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
24	8,8,8		3	12	21	30	39	48	57
26	$8^1 8^1 8$		1	10	19	28	37	46	55
28	$8^2 8^2 8$		26	8	17	26	35	44	53
30	$8^3 8^3 8$	10+10+10	24	6	15	24	33	42	51
32	$8^4 8^4 8$		22	4	13	22	31	40	49

Groupings of 9

Graph 57									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	~~16~~	~~18~~
2 cycles			~~12~~	~~16~~	~~20~~	~~24~~	28	32	36
3 cycles			~~18~~	~~24~~	30	36	42	48	~~54~~
4 cycles			~~24~~	32	40	~~48~~	~~56~~	~~60~~	~~72~~
5 cycles			30	40	~~50~~	~~60~~	~~70~~	~~76~~	~~90~~
6 cycles			36	~~48~~					
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		3	5	3	9	1	5	9
29	$9^1 9^1 9$		1	3	1	7	13	3	7
31	$9^2 9^2 9$		5	1	9	5	11	1	5
33	$9^3 9^3 9$	11+11+11	3	7	7	3	9	15	3
35	$9^4 9^4 9$		1	5	5	1	7	13	1

Graph 58									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	~~15~~	~~18~~	~~21~~	~~24~~	27
2 cycles			~~18~~	24	30	36	42	48	54
3 cycles			27	36	45	~~54~~	~~63~~	~~72~~	~~81~~
4 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		0	9	3	9	15	21	0
29	$9^1 9^1 9$		7	7	1	7	13	19	25
31	$9^2 9^2 9$		5	5	14	5	11	17	23
33	$9^3 9^3 9$	11+11+11	3	3	12	3	9	15	21
35	$9^4 9^4 9$		1	1	10	1	7	13	19

Graph 59									
Mukthayam 4 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	~~16~~	~~20~~	~~24~~	28	32	36
2 cycles			~~24~~	32	40	48	56	64	~~72~~
3 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		9	5	13	21	1	5	9
29	9^19^19		7	3	11	19	27	3	7
31	9^29^29		5	1	9	17	25	1	5
33	9^39^39	11+11+11	3	15	7	15	23	31	3
35	9^49^49		1	13	5	13	21	29	1

Graph 60									
Mukthayam 5 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~15~~	~~20~~	~~25~~	30	35	40	45
2 cycles			30	40	50	60	~~70~~	~~80~~	~~90~~
3 cycles			45	~~60~~	~~75~~	~~90~~	~~105~~	~~120~~	~~135~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		3	13	23	3	8	13	18
29	9^19^19		1	11	21	1	6	11	16
31	9^29^29		14	9	19	29	4	9	14
33	9^39^39	11+11+11	12	7	17	27	2	7	12
35	9^49^49		10	5	15	25	0	5	10

Groupings of 9

Graph 61									
Mukthayam 6 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~18~~	~~24~~	30	36	42	48	54
2 cycles			36	48	60	~~72~~	~~84~~	~~96~~	~~108~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		9	21	3	9	15	21	27
29	9^19^19		7	19	1	7	13	19	25
31	9^29^29		5	17	29	5	11	17	23
33	9^39^39	11+11+11	3	15	27	3	9	15	21
35	9^49^49		1	13	25	1	7	13	19

Graph 62

Mukthayam 7 pulses per beat

Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~21~~	28	35	42	49	56	63
2 cycles			42	56	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		15	1	8	15	22	29	36
29	$9^1 9^1 9$		13	27	6	13	20	27	34
31	$9^2 9^2 9$		11	25	4	11	18	25	32
33	$9^3 9^3 9$	11+11+11	9	23	2	9	16	23	30
35	$9^4 9^4 9$		7	21	0	7	14	21	28

Graph 63

Mukthayam 8 pulses per beat

Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~24~~	32	40	48	56	64	72
2 cycles			48	64	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		21	5	13	21	29	37	45
29	$9^1 9^1 9$		19	3	11	19	27	35	43
31	$9^2 9^2 9$		17	1	9	17	25	33	41
33	$9^3 9^3 9$	11+11+11	15	31	7	15	23	31	39
35	$9^4 9^4 9$		13	29	5	13	21	29	37

Graph 64

Mukthayam 9 pulses per beat

Time signature or *tala*			**3 /a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			27	36	45	54	63	72	81
2 cycles			54	~~72~~	~~90~~	~~108~~	~~126~~	~~144~~	~~162~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
27	9,9,9		0	9	18	27	36	45	54
29	$9^1 9^1 9$		25	7	16	25	34	43	52
31	$9^2 9^2 9$		23	5	14	23	32	41	50
33	$9^3 9^3 9$	11+11+11	21	3	12	21	30	39	48
35	$9^4 9^4 9$		19	1	10	19	28	37	46

Groupings of 10

Graph 65									
Mukthayam 2 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~6~~	~~8~~	~~10~~	~~12~~	~~14~~	~~16~~	~~18~~
2 cycles			~~12~~	~~16~~	~~20~~	~~24~~	~~28~~	~~32~~	36
3 cycles			~~18~~	~~24~~	30	36	42	48	54
4 cycles			~~24~~	32	40	48	~~56~~	~~64~~	~~72~~
5 cycles			30	40	~~50~~	~~60~~	~~70~~	~~80~~	~~90~~
6 cycles			36	~~48~~	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
7 cycles			42	~~56~~	~~70~~	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before mukthayam			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		0	2	0	6	12	18	6
32	$10^{1}10^{1}10$		4	0	8	4	10	16	4
34	$10^{2}10^{2}10$		2	6	6	2	8	14	2
36	$10^{3}10^{3}10$	12+12+12	0	4	4	0	6	12	0
38	$10^{4}10^{4}10$		4	2	2	10	4	10	16

Graph 66									
Mukthayam 3 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~9~~	~~12~~	~~15~~	~~18~~	~~21~~	~~24~~	~~27~~
2 cycles			~~18~~	~~24~~	30	36	42	48	54
3 cycles			~~27~~	36	45	54	~~63~~	~~72~~	~~81~~
4 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
5 cycles			45	~~60~~	~~75~~	~~90~~	~~105~~	~~120~~	~~135~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		6	6	0	6	12	18	24
32	$10^{1}10^{1}10$		4	4	13	4	10	16	22
34	$10^{2}10^{2}10$		2	2	11	2	8	14	20
36	$10^{3}10^{3}10$	12+12+12	0	0	9	0	6	12	18
38	$10^{4}10^{4}10$		7	10	7	16	4	10	16

Graph 67

Mukthayam 4 pulses per beat

Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~12~~	~~16~~	~~20~~	~~24~~	~~28~~	32	36
2 cycles			~~24~~	32	40	48	56	64	72
3 cycles			36	48	~~60~~	~~72~~	~~84~~	~~96~~	~~108~~
4 cycles			48	~~64~~	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		6	2	10	18	26	2	6
32	$10^1 10^1 10$		4	0	8	16	24	0	4
34	$10^2 10^2 10$		2	14	6	14	22	30	2
36	$10^3 10^3 10$	12+12+12	0	12	4	12	20	28	0
38	$10^4 10^4 10$		10	10	2	10	18	26	34

Graph 68

Mukthayam 5 pulses per beat

Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~15~~	~~20~~	~~25~~	30	~~35~~	40	45
2 cycles			30	40	50	60	70	~~80~~	~~90~~
3 cycles			45	~~60~~	~~75~~	~~90~~	~~105~~	~~120~~	~~135~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		0	10	20	0	40	10	15
32	$10^1 10^1 10$		13	8	18	28	38	8	13
34	$10^2 10^2 10$		11	6	16	26	36	6	11
36	$10^3 10^3 10$	12+12+12	9	4	14	24	34	4	9
38	$10^4 10^4 10$		7	2	12	22	32	2	7

Graph 69

Mukthayam 6 pulses per beat

Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~18~~	~~24~~	30	36	42	48	54
2 cycles			36	48	60	72	~~84~~	~~96~~	~~108~~
3 cycles			54	~~72~~	~~90~~	~~108~~	~~126~~	~~144~~	~~162~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		6	18	0	6	12	18	24
32	$10^1 10^1 10$		4	16	28	4	10	16	22
34	$10^2 10^2 10$		2	14	26	2	8	14	20
36	$10^3 10^3 10$	12+12+12	0	12	24	0	6	12	18
38	$10^4 10^4 10$		16	10	22	34	4	10	16

Graph 70									
Mukthayam 7 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~21~~	~~28~~	35	42	49	56	63
2 cycles			42	56	70	~~84~~	~~98~~	~~112~~	~~126~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		12	26	5	12	19	26	33
32	$10^{1}10^{1}10$		10	24	3	10	17	24	31
34	$10^{2}10^{2}10$		8	22	1	8	15	22	29
36	$10^{3}10^{3}10$	12+12+12	6	20	34	6	13	20	27
38	$10^{4}10^{4}10$		4	18	32	4	11	18	25

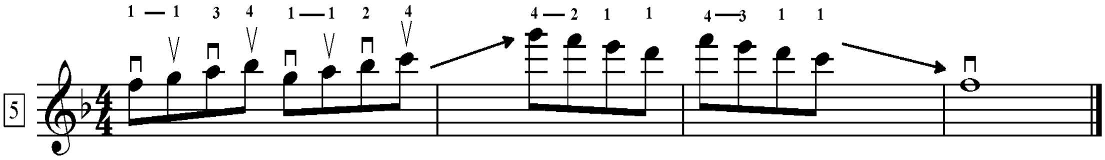
Graph 71									
Mukthayam 8 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~24~~	32	40	48	56	64	72
2 cycles			48	64	~~80~~	~~96~~	~~112~~	~~128~~	~~144~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		18	2	10	18	26	34	42
32	$10^{1}10^{1}10$		16	0	8	16	24	32	40
34	$10^{2}10^{2}10$		14	30	6	14	22	30	38
36	$10^{3}10^{3}10$	12+12+12	12	28	4	12	20	28	36
38	$10^{4}10^{4}10$		10	26	2	10	18	26	34

Graph 72									
Mukthayam 9 pulses per beat									
Time signature or *tala*			**3/a**	**4/a**	**5/a**	**6/a**	**7/a**	**8/a**	**9/a**
1 cycle			~~27~~	36	45	54	63	72	81
2 cycles			54	72	~~90~~	~~108~~	~~126~~	~~144~~	~~162~~
Gaps before *mukthayam*			gap	gap	gap	gap	gap	gap	gap
30	10,10,10		24	6	15	24	33	42	51
32	$10^{1}10^{1}10$		22	4	13	22	31	40	49
34	$10^{2}10^{2}10$		20	2	11	20	29	38	47
36	$10^{3}10^{3}10$	12+12+12	18	0	9	18	27	36	45
38	$10^{4}10^{4}10$		16	34	7	16	25	34	43

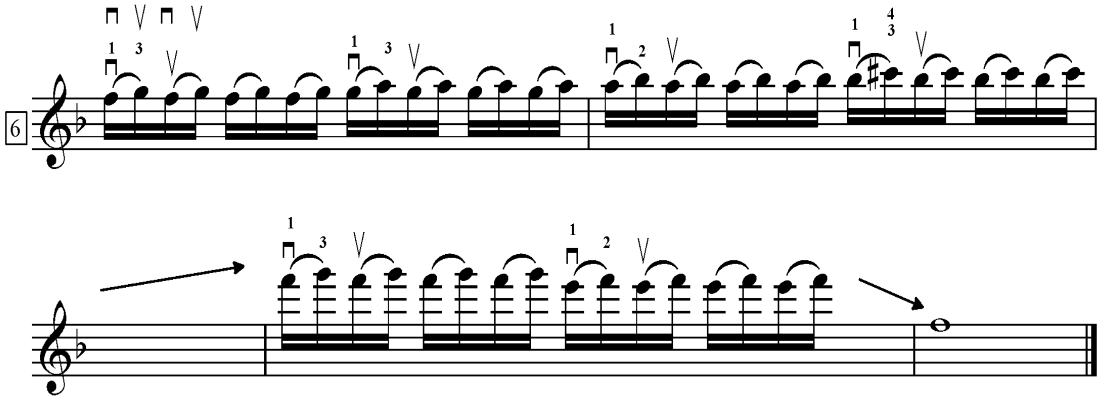
Appendix C: Linear Plectrum Exercises Using *Konokol*

Linear Patterns on the E string

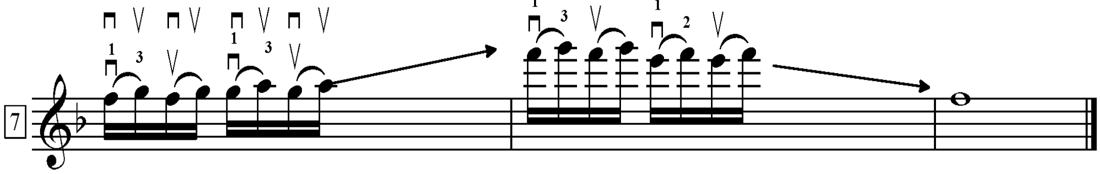
Most sitar players use mainly the index and middle fingers on the left hand regardless of interval. These are sitar like patterns adapted for plectrum guitar.



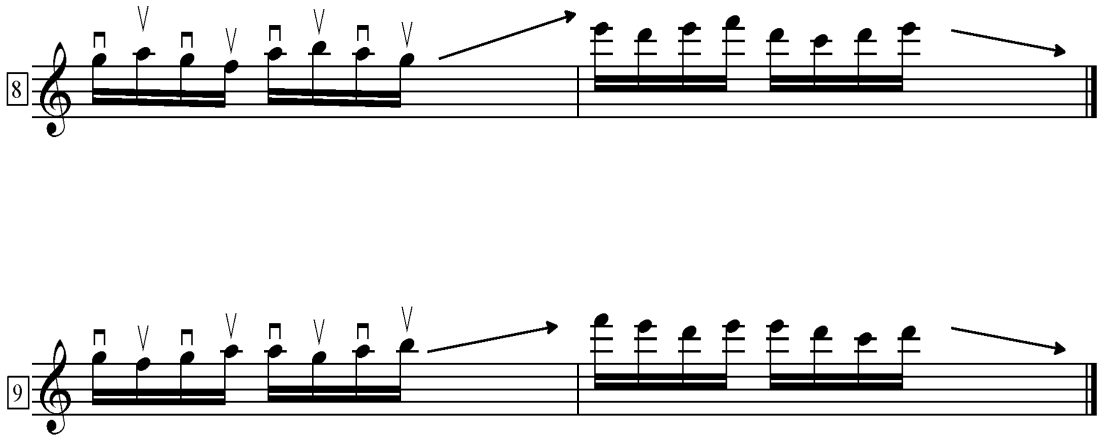
D Harmonic minor



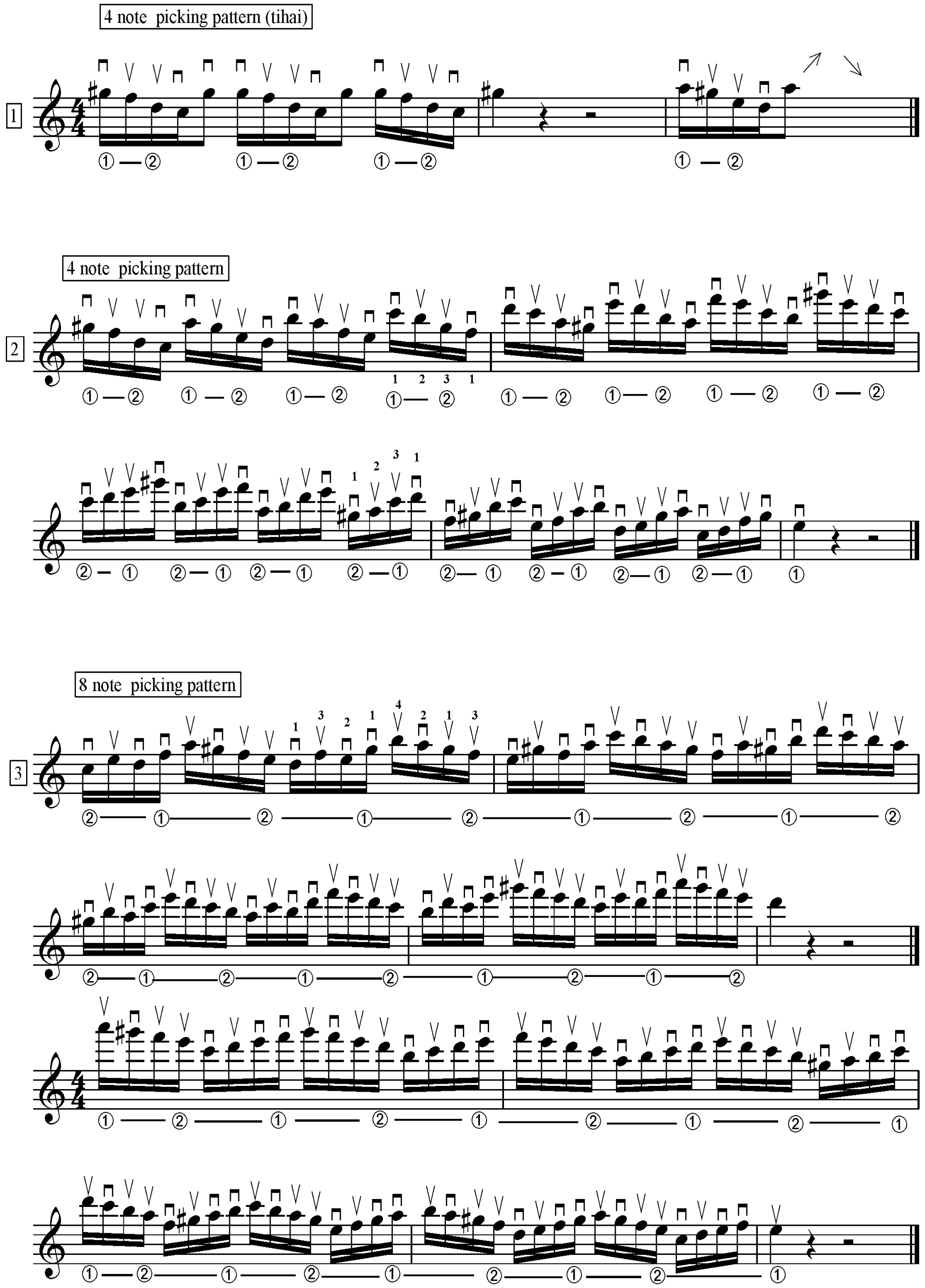
D Harmonic minor



C major

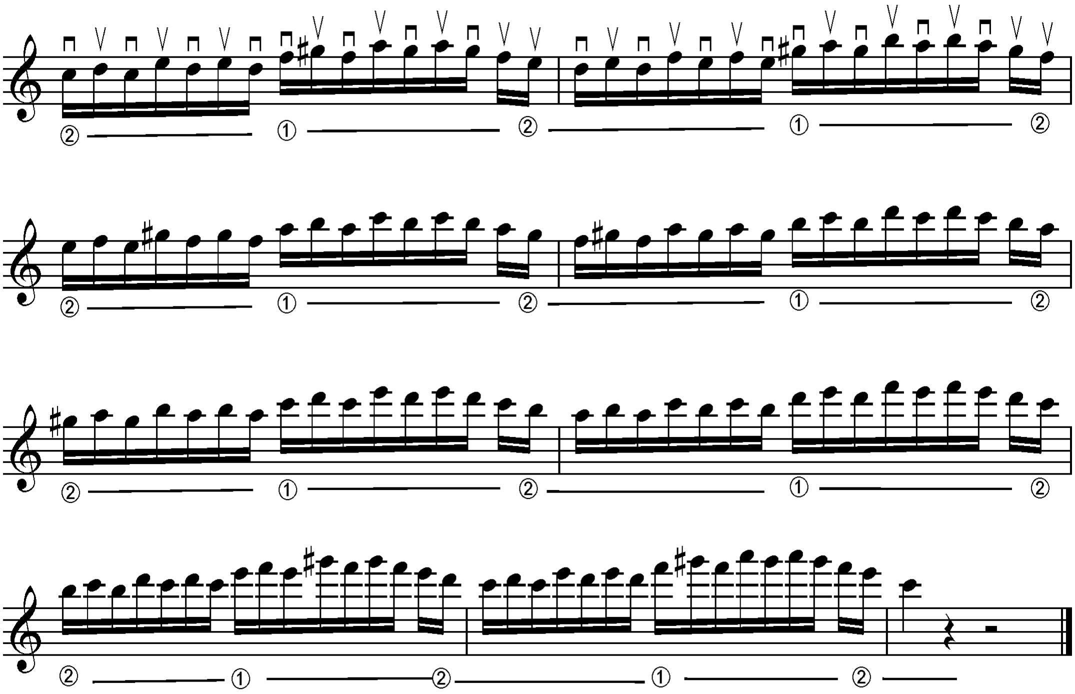


Linear Patterns on the E and B strings (A harmonic minor)



16 note picking pattern 7+7+2

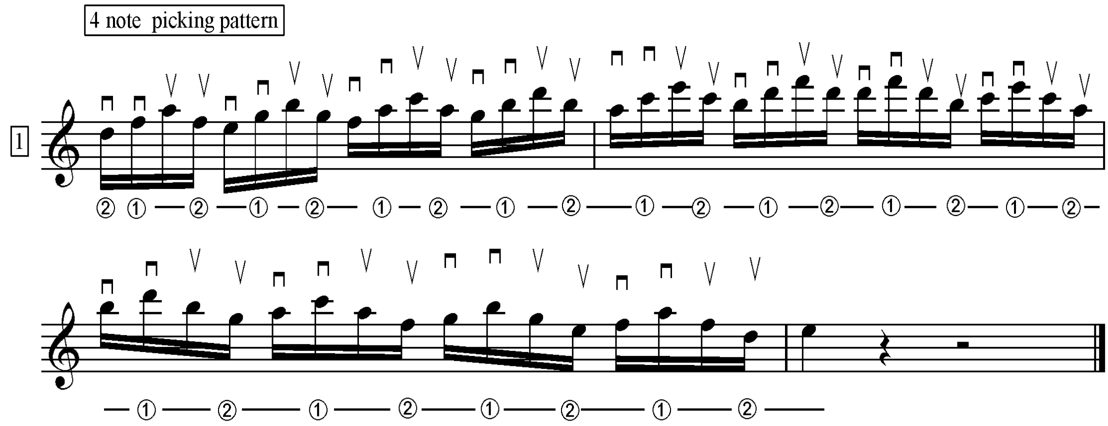
4

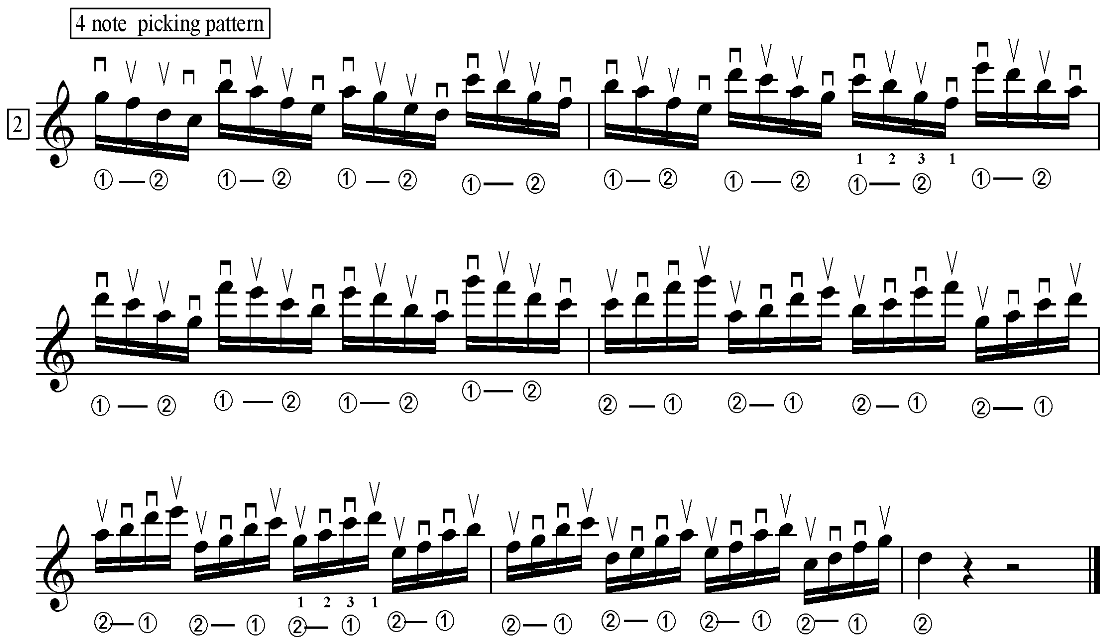


16 note picking pattern 5+5+6

5

Linear Patterns on the E and B strings (Cmajor)



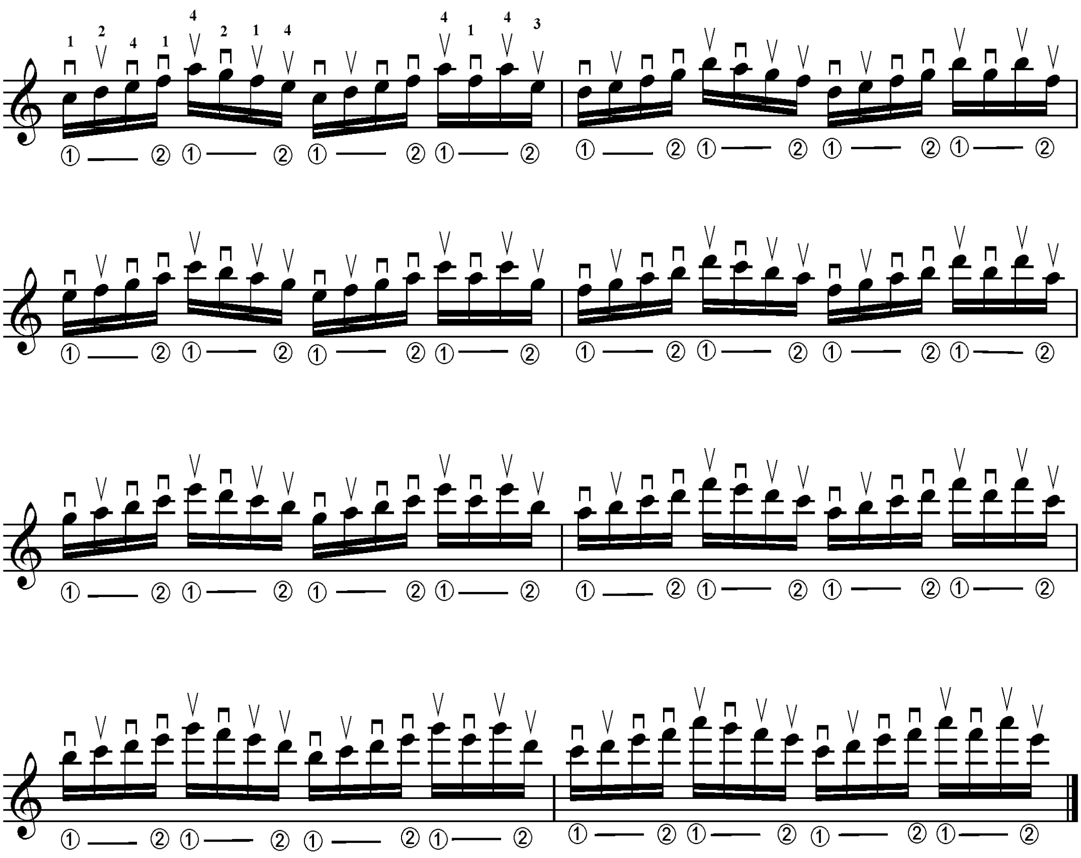


8 note picking pattern

3

16 note picking pattern 8+8

4

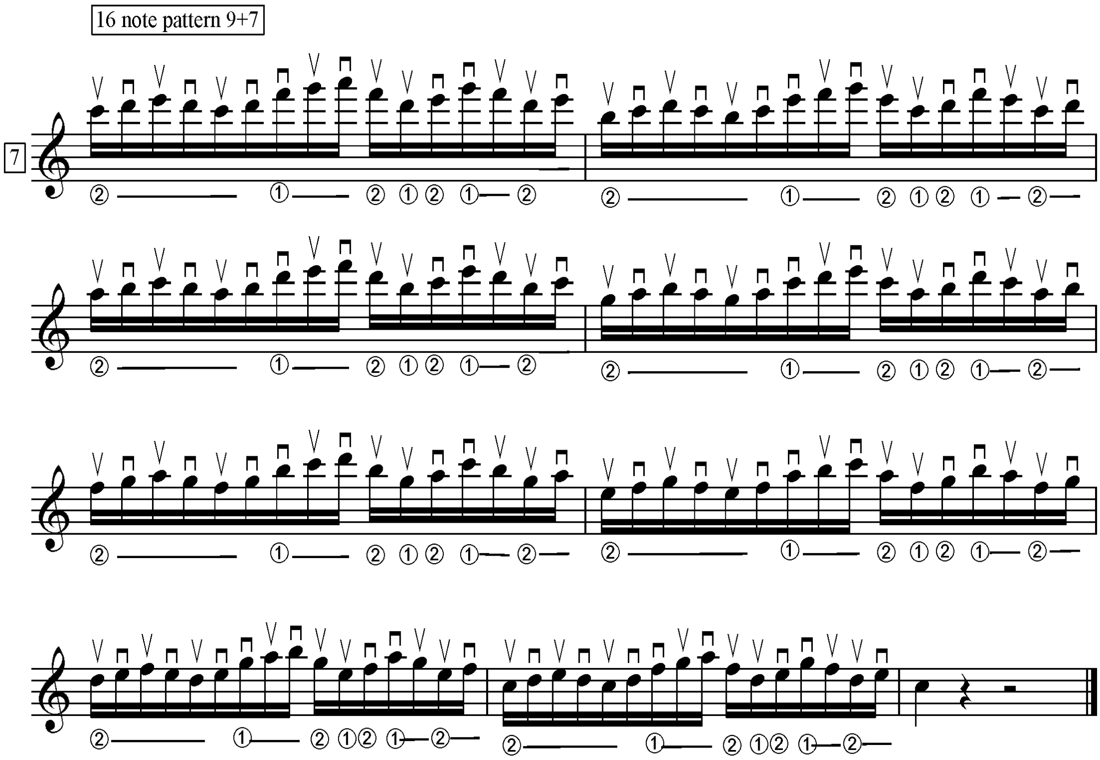


8 note picking pattern 4+4

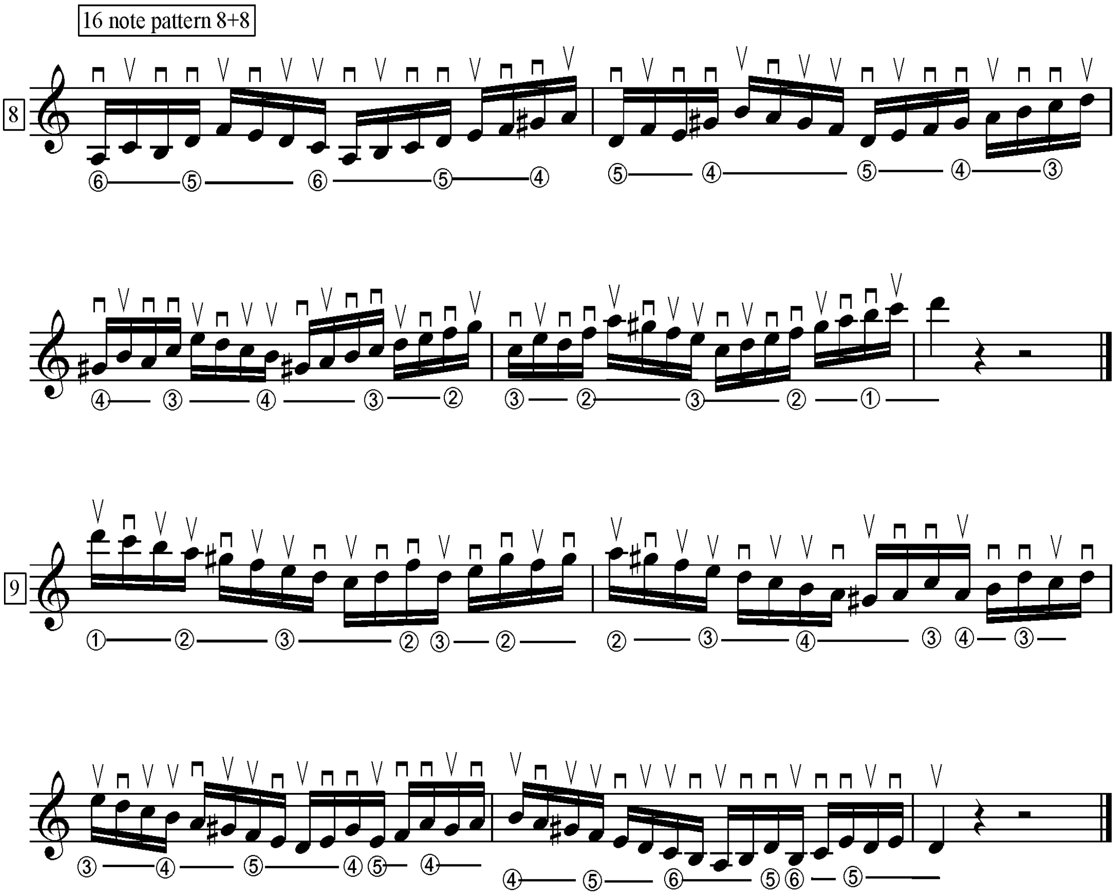
5

16 note pattern 9+7 with gaps

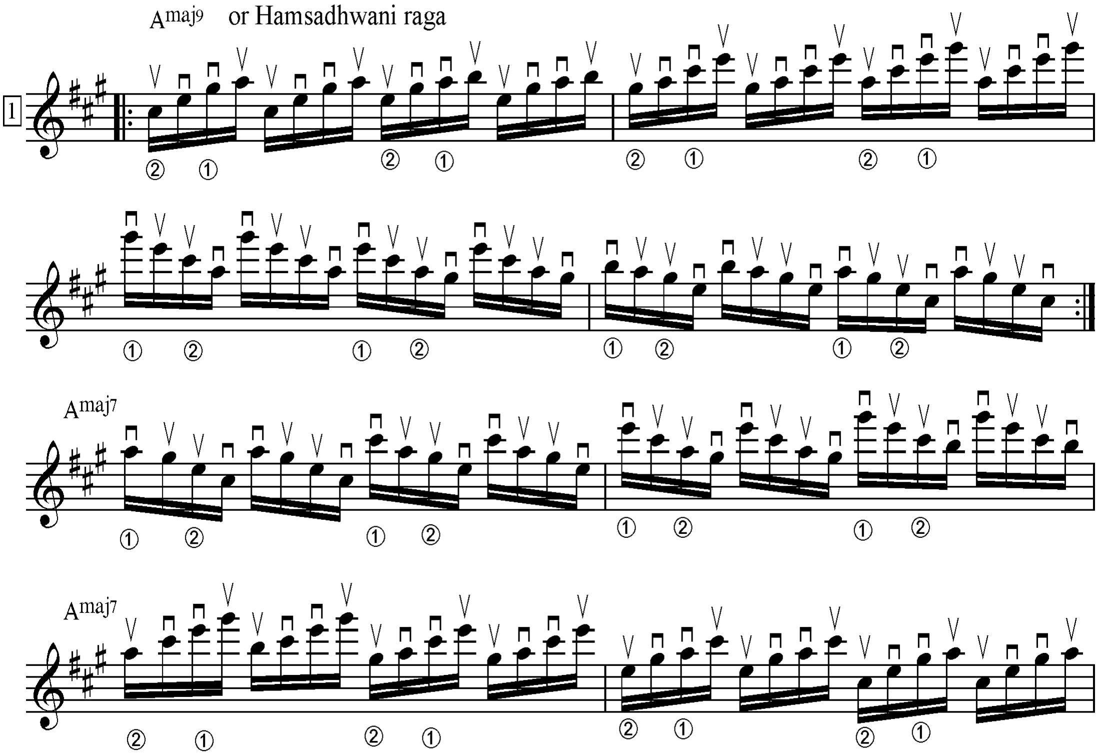
6

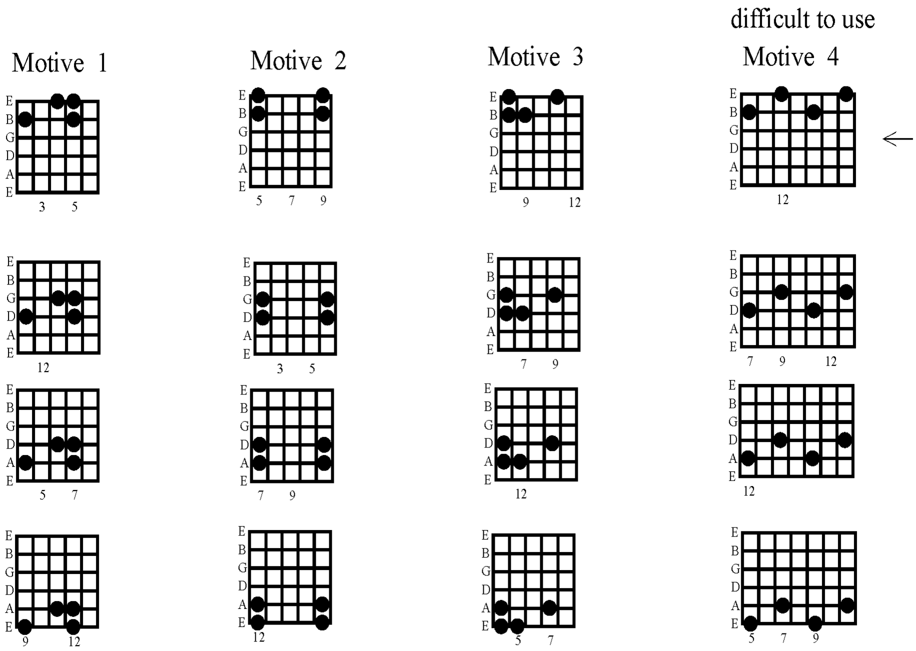

16 note pattern 9+7
7

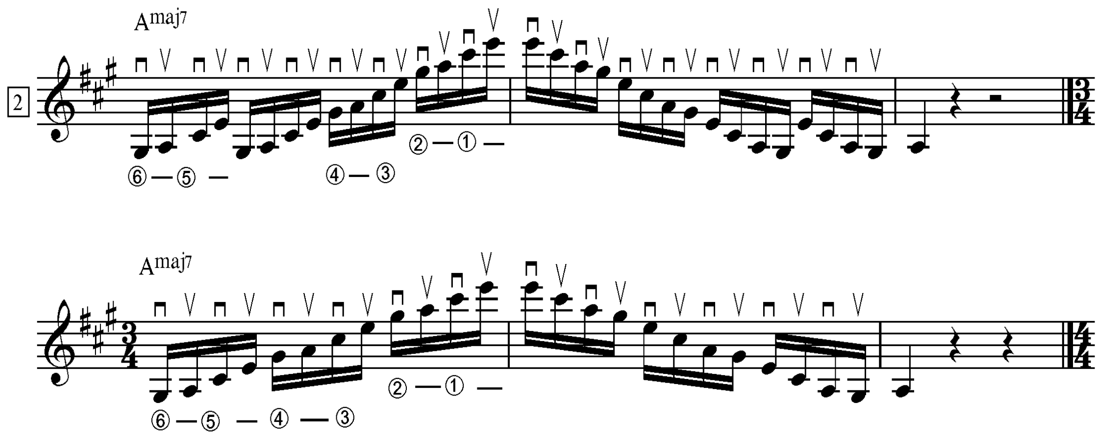
Non linear patterns (A Harmonic min)

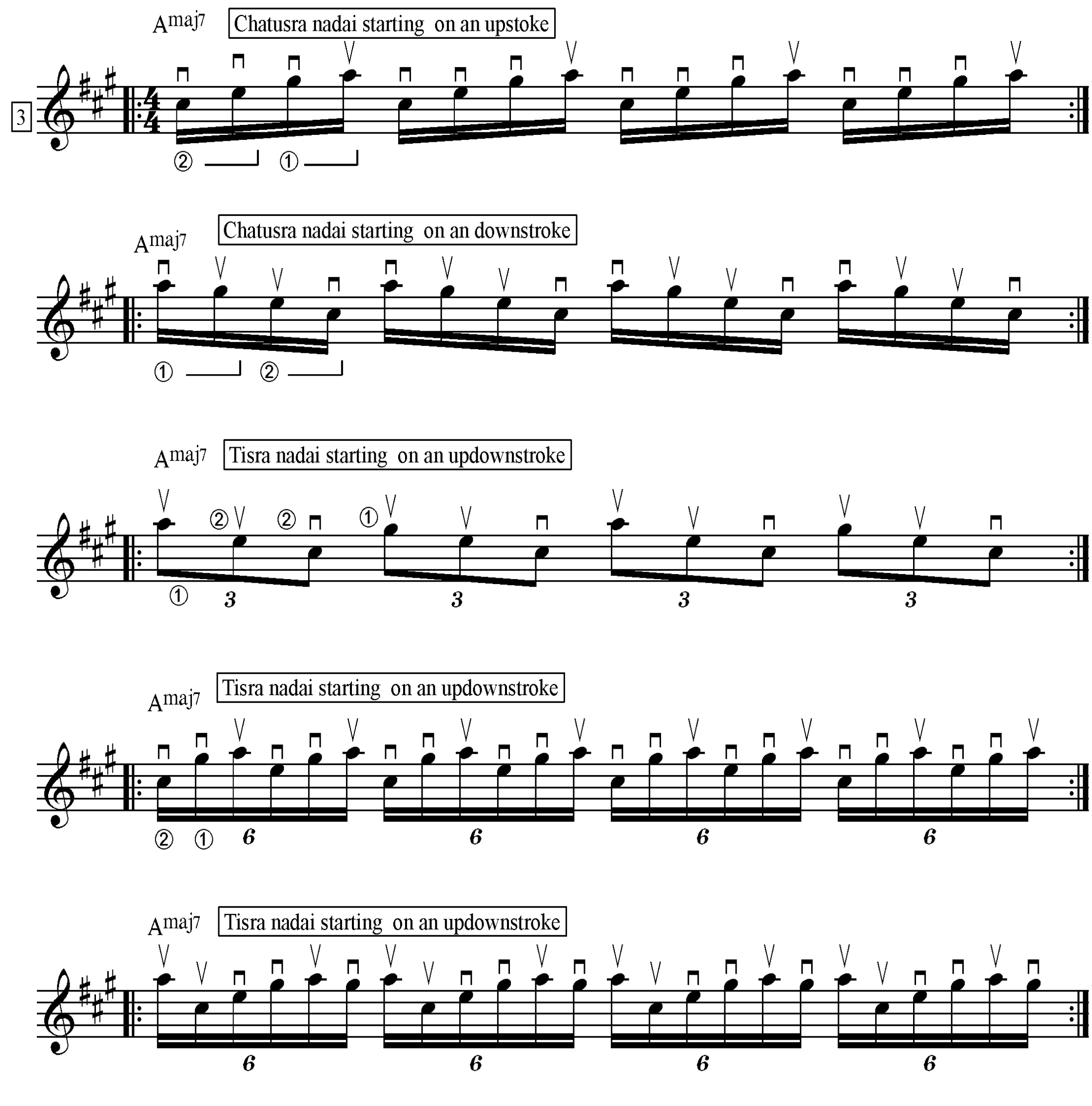


Linear Arpeggios and Nadai.






2
Amaj7
Amaj7


3
Amaj7
Chatusra nadai starting on an upstoke
Amaj7
Chatusra nadai starting on an downstroke
Amaj7
Tisra nadai starting on an updownstroke
Amaj7
Tisra nadai starting on an updownstroke
Amaj7
Tisra nadai starting on an updownstroke


Tisra nadai starting on an downstroke
Amaj7
Tisra nadai starting on an upstroke
Amaj7
Misra nadai starting on an upstroke
Amaj7
Misra nadai starting on an downstroke
Amaj7
Sankirna nadai starting on an upstroke
Amaj7
Sankirna nadai starting on an downstroke
Amaj7

Appendix D: Compositions by Glenn Rogers

Amelie's Courtyard for solo guitar.

Glenn Rogers 2014

Amelie's Courtyard

Glenn Rogers 2014


IX
a m i p i m a
rit
a tempo
p
f
mf
ponti cello
ff
arco
p i
a m i


a i m
p
rit
a tempo
D.S. al Coda
mf
p p
CODA
a m
p p
f
a tempo
rit.
accel.
mf
a m a m i p
f
rit.
fine
mf
p

Etude 1

For solo guitar

Composed by Glenn Rogers (2012)

Allegro

Etude 1

Glenn Rogers


CVII


CII
rall
a tempo
mp
p
mf
f
p m i (etc)
pp
CI


57
59
61
rall
f
63
a tempo
mf
f
65
67
69
a
71
a
73
a
75
77

79
mf
81
p a p m i
p a p m i
f
p
a tempo
pp
84
molto accelerando
86
p i m p i m p i m
mp
a tempo
89
f
91
93
ff
95
97
rall
mp
p
99
fine

The Wait

For solo classical guitar

Composed by Glenn Rogers (2013)

The Wait

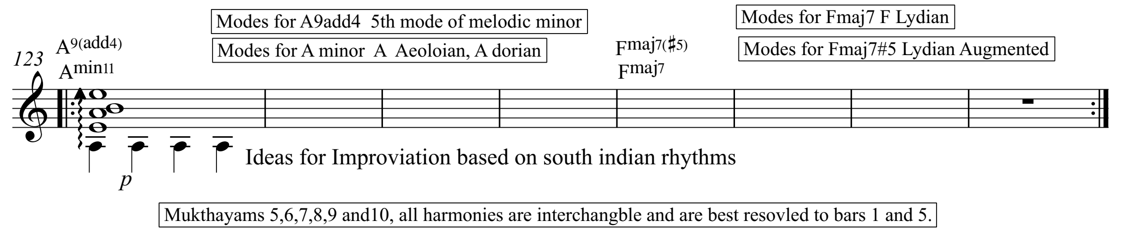

p a m i
p a m i
a m i p
p i m a
rall
a tempo
p a p m i
rit
mp
p a p m i


freely
Improvise over the following chord sequence then continue (refer to page 6).
A tempo
A9(add4)
Amin11
Fmaj7(♯5)
Fmaj7
A tempo


gliss.
p a p m i
p a p m i
gliss.
gliss.
p a p m i
rall
A tempo


106
110
113
a
a
m i
117
rall
a tempo
accel.
p i m
f
119
p
fine

Improvised section Modes and Cadences.

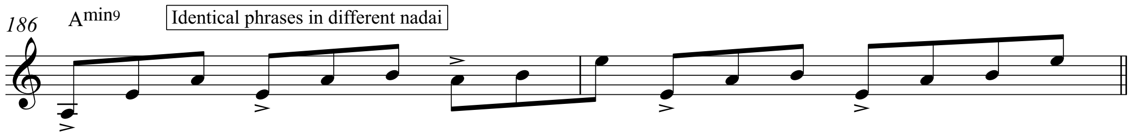


Mukthayams.

Chord Voicings

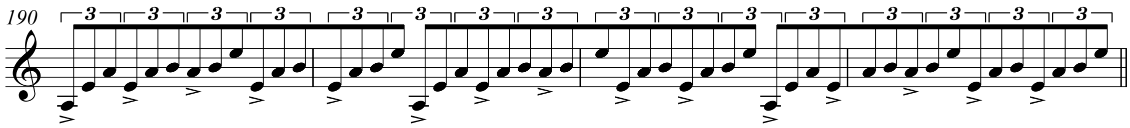
Nadai Patterns

Identical phrases in different nadai

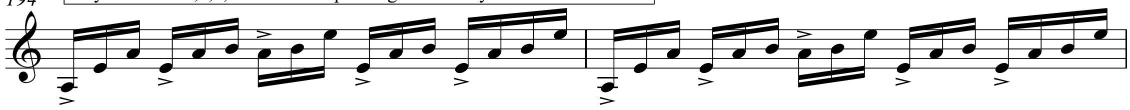


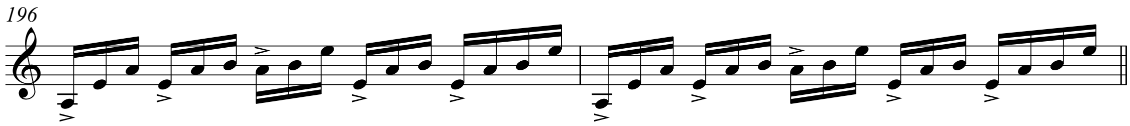
Each new nadai phrase is placed so it rhythmically resolves on the sum of the cycle.

Previous phrase played three times takes up 4 bars

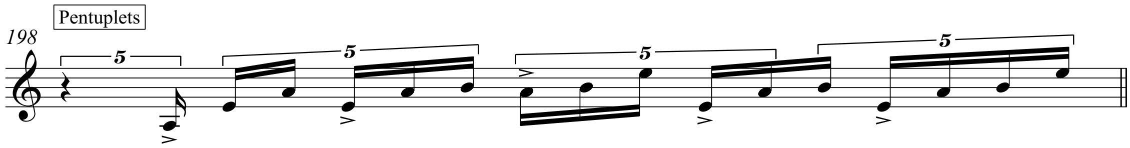


Play each bar 1,2,3, or 4 times depending on where you want to resolve it

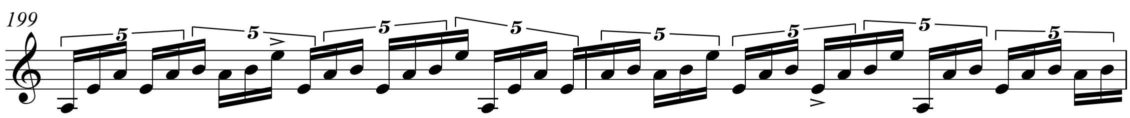


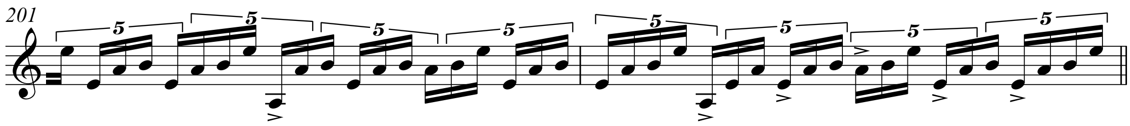


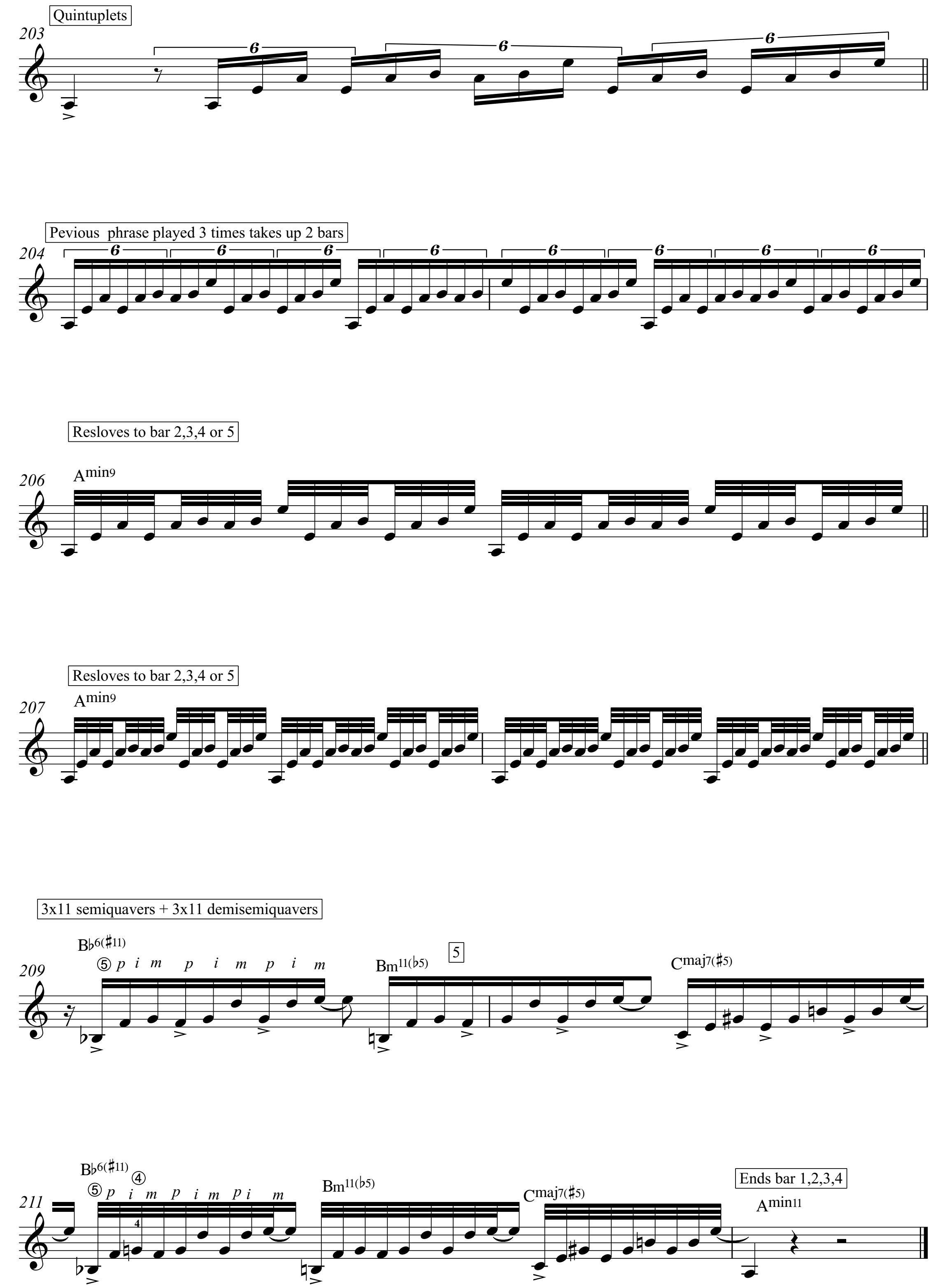
Pentuplets



Previous phrase played 5 times takes up 4 bars






Quintuplets
203
6
6
6
Pevious phrase played 3 times takes up 2 bars
204
Resloves to bar 2,3,4 or 5
206
Amin9
Resloves to bar 2,3,4 or 5
207
Amin9
3x11 semiquavers + 3x11 demisemiquavers
209
B♭6(♯11)
⑤ p i m p i m p i m
Bm11(♭5)
5
Cmaj7(♯5)
211
B♭6(♯11)
⑤ ④ p i m p i m p i m
Bm11(♭5)
Cmaj7(♯5)
Ends bar 1,2,3,4
Amin11

The Wait

Composed by Glenn Rogers 2014

For flute and classical guitar

The Wait

for guitar and flute composed (2013)

Glenn Rogers

Tempo 80 bpm or above


freely
freelly
rit


33
A tempo
mp
A tempo
mf
p i m
p i m
p i m
mp
36
mf
p a m i
mf
38
f
f
p a m i
40
42
mp
mp


44
mf
3
a m i p
mf
p i m a
f
47
50
52
rall
rall


54
a tempo
mf
rit
a tempo
p a p m i
mf
57
p a p m i
59
f
p a p m i
f
61
mf
63


66
68
mf
ff
m
p
a
mf
ff
70
freely
mf
freely
mp
Rubato
72
play spaciously
p
Rubato
play spaciously
sul tasto
p

76
pp
80
Play top note or play multiphonics or sing the lower notes
mp
p
84
pp
88
p
92
Fmaj7
Ponticello
p
f
p
f


96
A tempo
play with rhythmic energy
p a p m i
right hand fingering is the same throughout
this passage
Arco
98
100
102
104


106
mf
108
f
gliss.
p a p m i p a p m i
gliss.
gliss.
f
③
110
mp
p a p m i
mp
112
rall
mp
p
114
A tempo
f
f


118
120
122
124
p a p m i
f
f
126


rall
a tempo
accel.
rall
accel.
rall
fine
fine

Hamsadhvani and Yaman

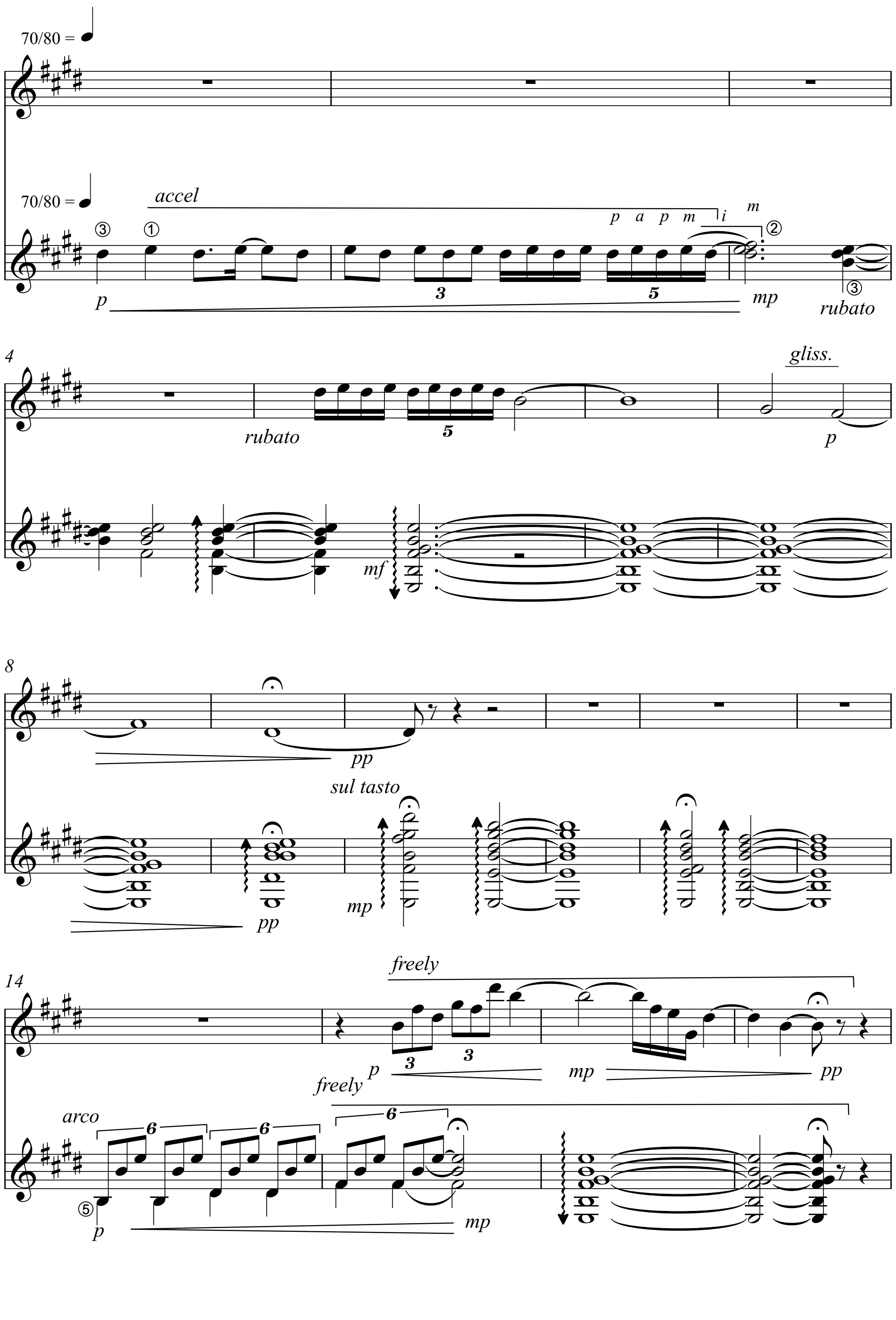
For flute and classical guitar

Composed by Glenn Rogers 2013

Hamsadhvani and Yaman.

for flute and classical guitar

Glenn Rogers



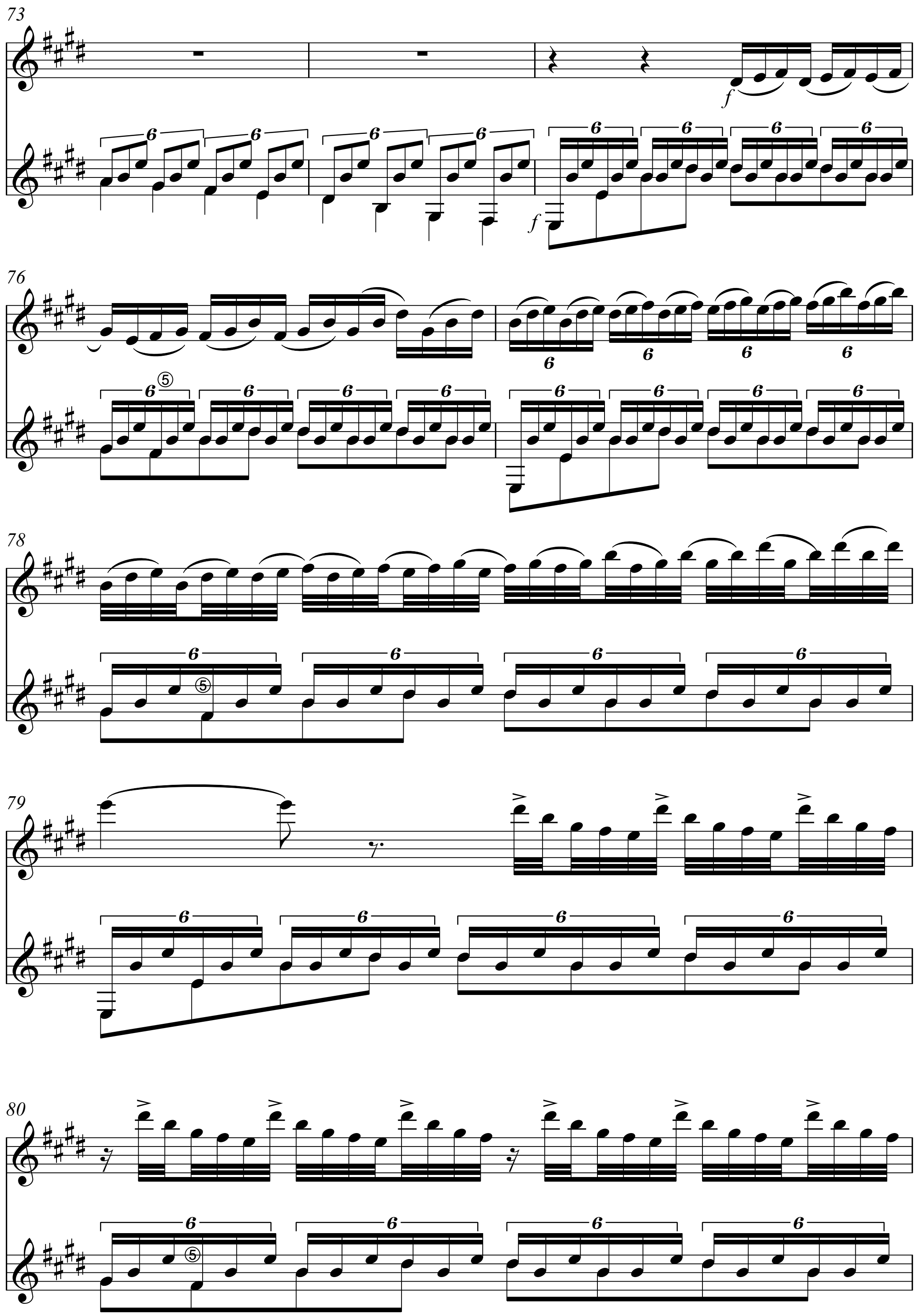

18
a tempo
a tempo
p i m
20
gliss.
rall
rall
26
p p p i m
28
29


31
p
33
35
f
37
gliss.


41
43
45
47
p m i p m i
mf
mf
49
f
mf
p m i p m i
f
mf
f


51
53
55
mukthayam 3x9
mukthayam 3x9
58
p a m i p a m i
59
p a m i p a m i p


61
63
65
p a p
67
m i
p
p a p m i
70
pp
p


73
f
f
76
78
79
80


81
83
85
p m i p m i
f
f
87
p
play freely
p
90
p
mp
p


95
play freely
play freely
p
mp
pp
mp
pp
99
mp
f
mp
f
102
play freely
molto rall.
p
pp
molto rall.
p
pp
105
fine
ppp
fine
ppp

Miyan ki todi

For flute and classical guitar

Composed by Glenn Rogers 2013

Miyan ki todi

for flute and guitar

Glenn Rogers


19
gliss.
mp
3
23
gliss.
molto rall
gliss.
pp
mf
27
6
A tempo
pp
mf
f
p
A tempo
31
gliss.
mp
p
37
pp


40
f
mp
f
mp
43
mf
mf
46
49
52


54
56
57
mf
f
p a m i p
a
④ ③
p i m a p i m a
⑤
59
p
pf
63


65
67
mp
mp
69
6
mf
6
71
73
mf
6
f
6
75
3
3
3
f


78
80
81
ff
ff
83
p
p
88


93
p a m i
96
p a m i
99
100
p
102
mf
p
mf p a p m i
104
p a p m i


106
ta
explosive vocal sound
ta
ta
ta
explosive vocal sound
ta
ta
p a p m i
p a p i
109
ta
m a m i p a p i m i p a p m i
112
115
④
p a p i m


117
mf
mf
p a p m i
119
121
122


123
④
f
②
④
f
125
p
p
126
mp
ff
mp
ff

Variations on Bhimpalasi for flute and classical guitar 2015

Composer Glenn Rogers

Variations on Bhimpalasi

for flute and classical guitar (2015)

Glenn Rogers


24
28
mp
mp
p i m
f
mp
p i m
f
mp
32

Variation 1
Variation 1
play with thumb


44
48
mf
f
p m i a m


52
Variation 2
56
Variation 2
harm 7
play freely and dramaticlly
harm 5
harm 4
harm 12
rall
mf
sf
ff
fff
f
play freely harmonics or whistle tone any octave
60
mf
pp
harm 7
harm 5
64
ponticello
ff
mp
p
p a p m i p
p i m
hit fretboard
ff


68
72
harm 7
harm 5
harm 4
p
mf
sf
f
fff
ff
rall
76
mp
mf
80
p a p m i p a
84
pp


Variation 3
Variation 3
gliss.
88
92
96


gliss.
m
a
gliss.
100
③
7x4
6x4
7x4
6x4
p a m i p a m i p m i
③ ③ ② ③
④ ②
③
i
p
③
m
p i m
p m i p a m i


5x4
104
5x4
p a p m i
4x4
4x4
p a m i
3x4
3x4
4x4
4x4
p i m a p i
108
2x4
rall
ff
2x4
p i p i
rall
ff

♩.=♩ Variation 4
112
p
mp
p
mp
♩.=♩ Variation 4
p
mp
③
116
6
120
p
p
6
124 m
3
⑤
p a 5 p m i a 6
④
6
ponti cello
p
6
p


128
rall
mp
p
p i m p i m
6
arco
3
rall
mp
p
ponti cello
arco
132
136
81
Variation 5
mf
rall
6
m
mp
pp
81
Variation 5
mf
p
140


144
148


108
152
f
i
mf
156
160
164


Variation 6
168
Variation 6
172
176


4.
4.
4.
6
6
6
9
9
9
10
10
10
180
mf
f
mf
f
184
188


a i m p i p
m
i
192
f
mf
p
196
200
simile


mf
6
mf
f
204
harm 12
f
pp
rall
208
fine
ff
mp
rall
fine
ff


f Variation 7
tam
The notes on tam can be played and vocalised simultaneously or just vocalised . The guitarist can also just vocalise tam.
f Variation 7
(ta ki ta tam. ta ki ta tam. ta ki ta) (ta ka di na tam. ta ka di na tam.
ta ka di na (ta di gi na tom tam .ta di gi na tom tam. ta di gi na tom
tam
mf
212
mf
tam


216
p i m p i m p
p i m p i m p
220
224
mf
f
p i m


228
mf
p m i
p
232
f


236.
Can be played in half time
Can be played in half time
240
fine
fine

Appendix E: Interview with John McLaughlin on Konokol

This discussion between Glenn Rogers and John McLaughlin explores the relationship between *konokol* and Western education, pitched instruments, Western composition and harmony, mathematics, numbers, biology, philosophy, and religion. It is also a general discussion about *konokol*, mathematical structures and other related phenomena (conducted in Perth during his 2016 tour of Perth).

ROGERS From listening to your music, I can hear the influence of *konokol* on your guitar playing and composition style. Can you tell me the most important ways in which *konokol* has influenced your thinking and the way you play guitar and compose?

McLAUGHLIN Rhythm is the heartbeat of the world. The entire universe is rhythmic in its movements. Rhythm in jazz is primordial. You can play a wrong note, but a note out of time is disturbing to our nature. There are two cultures and their musics that have influenced me since I was a teenager, and they are the music of North and South India, and the Flamenco traditions. In both of these musical traditions, rhythm has been developed to a degree of high sophistication. It became clear to me even then, that a mastery of rhythm is essential in *all* playing. However, it was only after I began studying Carnatic music, the music from South India, in 1972 did I begin to realise the fabulous system of learning rhythm that *konokol* truly is. In 1974–75, I became an extra-curricular student of Pandit Ravi Shankar, who was gracious enough to further develop my studies in *konokol*; even though he was a musician from North India, he had mastered the South Indian system many years previously. By this time, the impact of learning *konokol* had begun to emerge in my playing and compositions.

ROGERS I have found that applying complex Indian rhythms to complex harmony doesn't always work. How do you find applying a complicated *tihai* or *mora* to complex harmonic progressions?

McLAUGHLIN No it doesn't work very well for the simple reason that rhythm is essentially linear, and requires melody as opposed to harmony, which has vertical structure.

ROGERS This next question is one that puzzles me and I don't have a clear answer but I have often pondered it. The answer is probably too big to comprehend but I'll ask it anyway. So many phrases in Indian music are based on the number three, along with many other aspects in life, for example, three-dimensional space, the holy trinity, biology, the three areas of the brain, the Hindu triad (Brahma, Vishnu and Shiva), and the way we recall patterns seems to be group in threes. There seems to be something going on here; what are your thoughts on this?

McLAUGHLIN My personal opinion is that all numbers are a link to the transcendental dimension. In a sense I'm speaking about mathematics, but rhythm is an organic-dynamic expression of numbers and mathematics. The three is a fundamentally very important number, but playing music in rhythmic cycles of 5, 7, 9, 11 etc. all have a specific impact on the psychophysical organism. To be able to improvise freely in these rhythmic cycles takes substantial work, and *konokol* can be extremely helpful here. Actually, to me, it is the greatest system in the world for understanding and mastering the articulation of rhythm.

ROGERS Complex *korvais* and *moras* can work well with simple harmony and atonal music, but not many Western composers combine traditional *korvais* and *moras* in these contexts: it is often just left to drummers or percussionists. Why is this an aspect of Indian music that is not so much explored in simple Western harmony and atonal music?

McLAUGHLIN I find that the study of *konokol* has been much neglected in the West. The thing about rhythm is that it is essentially sensual and even sexual in some rock music. The attitude in the West among composers has been traditionally to avoid these kinds of sentiments in music, especially contemporary classical music. But this is what I find particularly satisfying in jazz and Indian music. The inclusion of rhythm and its sensual aspect completes the 'intellectual' and 'spiritual', if you will, aspects of a whole music. It reflects the human psyche and its dimensions completely.

ROGERS Many universities still teach the 'French time name' system (inadequate compared to *konokol* in my opinion), although this is slowly changing. Do you think *konokol* will eventually become the dominant education tool in jazz and classical music in universities in the West?

McLAUGHLIN That's a tough question: as far as the classical music universities are concerned, very unlikely. The only time I hear any kind of steady beat in 'classical' music is from the 17th, 18th and 19th centuries. The teaching of *konokol* in schools of jazz music would be advantageous since the student needs no drum, or percussion instrument to master rhythm. The important thing to remember in Jazz is that everyone plays with the drummer, and to really play with a drummer you need to understand exactly what he's [sic] playing and his concept of mathematical dynamics. Without this, there will be some floundering. *Konokol* gives a complete understanding of rhythm and its mathematical subdivisions using only the voice and the hands. Once you can sing the rhythms you hear in your head, and comprehend and articulate the subdivisions in the rhythmic cycle, it’s simply a question of application to your respective instrument.

ROGERS After learning *konokol* did you begin to think more mathematically about rhythm and form in music?

McLAUGHLIN Of course. It's inevitable. Rhythm and its impact on the psychophysical is one of the more fascinating aspects of playing, especially improvising. I have the impression that schools and colleges in general feel that *konokol* is specifically Indian, and they have not seen the true global implications of its integration into Western music.